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ABSTRACT

This document contains the speeches, and subsequent discussion, presented at the International Ex-Student Conference on Energy held at the University of Texas at Austin, April 26-30, 1976. Speakers included technical experts and representatives from an oil exporting country and from developed and developing oil importing countries. Energy sources, technologies, and utilization constraints were considered along with the impact of energy on the quality of life, food production, international finance, and economic growth. (IRT)

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Proceedings: International Ex-Students' Conference on Energy

The University of Texas at Austin April 26–30, 1976

ED153326

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Center for Energy Studies

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The World Energy Problem

The International Ex-Students Conference on Energy was held at The University of Texas at Austin during the period April 26–30, 1976. This was a particularly propitious time for holding such a conference, coming as it did some thirty months after the momentous events of late 1973 which had made the world energy crisis visible for all the world to see.

It is true that the world energy problem had been long in the making, and that a few farseeing individuals, to their credit, had long predicted its coming. However, it was not until October 1973 that the reality of the problem became obvious. This came about when the Organization of Petroleum Exporting Countries (OPEC) suddenly quadrupled the price of crude oil, curtailed its own production, and also, for a period of some months, placed an embargo on oil exports to the United States and other Western nations, thus demonstrating concretely the apparent extensive power to be enjoyed for at least some indeterminate period of time by these less-developed oil-exporting countries. Concomitantly, the vulnerability of the importing nations to oil diplomacy became evident. It was the first time that modern industrial nations had to bow to pressures from the less industrially developed nations.

By the Spring of 1976, a number of consequences resulting from the new world energy situation were evident, a number of other early expectations had failed to materialize, and above all, a host of important questions and uncertainties remained. Massive quantities of "petro-dollars" had in fact shifted from the rest of the world to the oil-exporting countries, their oil revenues increasing from about $24 billion in 1973 to some $100 billion in 1975. Along with the resources, of course, went enhanced military, political, and economic capabilities and influence. Also, it seemed clear that the much higher price for oil had contributed to worldwide inflation and to the worldwide recession, with particularly adverse impacts on the poorer, oil-importing nations. The desirability, if not absolute necessity, of alternative sources of energy supply, particularly nuclear fission energy, seemed self-evident, creating dangers of increased proliferation of nuclear weapons to nations not previously possessing them.

On the other hand, a number of early expectations—both hopes and fears—had failed to materialize. First of all, any expectations that OPEC would collapse seemed much less likely by the Spring of 1976 than it had earlier. Secondly, the fear that OPEC's petro-dollars would be used to buy up and thus to exercise direct control of extensive productive resources in the industrial nations had by 1976 proved groundless. Moreover, the world's financial institutions seemed to have succeeded in recycling the petro-dollars far more efficiently than had earlier been anticipated, and the world economy seemed to be recovering from the most severe recession since the Great Depression of the Thirties in spite of the radically changed energy situation.

No event since perhaps World War II had created such a worldwide impact. Everyone became a concerned participant. Government, industry, science, and education—all were involved and had important roles to play. It was the purpose of the International Ex-Students' Conference to clarify

the issues involved and to explore some of the possible courses of action available to the various participants in coping with these issues.

The goal of the Conference was to further the understanding among people influential in energy policy and technology throughout the world. Since many of the people who hold key energy-related positions around the globe are among the University's 7,000 foreign national and quarter of a million domestic alumni, this Conference provided an opportunity for world energy leaders to explore this vital problem under the common bond of The University of Texas. And because the University has been a leader in energy education, research, and public service since the turn of the century, it provided an environment uniquely conducive to seeking international understanding.

The University hopes that after meeting and discussing the worldwide energy problem and its complex implications, both speakers and participants have returned to their home countries with a broader and deeper understanding of the energy problem—an understanding which they will be able to bring to bear in at least some way for the greater good of all humanity.

The University of Texas at Austin Today

Since it first opened its doors in 1883 with one building and 221 students, The University of Texas at Austin has grown into a city within a city, a community of more than 50,000 people, including 42,000 students, 1800 faculty, and 9000 support personnel.

Although the UT campus is still centered on the original tract which gave the school its nickname, "The Forty Acres," the University has expanded dramatically in both facilities and scope over the years. The campus now encompasses some 300 acres with 110 buildings, the curriculum offered by the University's 16 schools and colleges includes virtually every major field of study, and such activities as scientific research and consultation on national affairs have assumed a major role at UT.

The University's esteem has grown along with its size. The current faculty includes several members of the National Academy of Sciences and the National Academy of Engineering, a Pulitzer Prize winner in history, and holders of about 60 endowed chairs and professorships. The latest national assessment of doctoral education placed 23 of the University's Ph.D. programs in leading categories of their respective fields. On the basis of those ratings, UT Austin ranked fourteenth among U.S. universities in overall academic quality.

This academic excellence is particularly notable in science and engineering. For example, over the years the University has graduated more petroleum engineers than any other institution in the world, and over half the world's Ph.D.'s in petroleum engineering received their doctorates from UT Austin.

Drawn by the University's reputation and curricular variety, students come to UT Austin from every state in the United States and from some 90 other countries.

Today the Austin campus includes the new renowned Humanities Research Center, a Computation Center containing one of the world's largest and most powerful computer systems (the CDC 6600/6400), and the Lyndon B. Johnson School of Public Affairs, devoted to providing in-depth education in public policy and related areas. Standing beside the School of Public Affairs, the LBJ Library houses Presidential documents, special exhibits, and gifts presented to the late President Johnson by heads of state throughout the world. As the only American Presidential library on a university campus, it provides an important reflection of national and international history from the early 1930's through the late 1960's.

The University's own library has achieved international recognition for both its size and the quality of its collections. With its number of volumes approaching 4,000,000, the UT Austin Library is the largest within an 800-mile radius and the tenth largest academic library in the United States. Its archive of Twentieth Century British and American literature is so outstanding that British authority Anthony Hobson cited the University Library as one of the 32 great libraries of Western Europe and North America. Only five U.S. libraries were named in the Hobson study. The UT Austin Library also has notable collections in Latin American history and culture, Texas and Southern U.S. history, the history of science, theater history, and the history of photography.

Housed in the Harry H. Ransom Center, the Michener Collection provides another important view of the Twentieth Century. A gift of the novelist James A. Michener and his wife, the collection brings together more than 300 Twentieth Century American paintings. It serves as an important resource for both art history and research in modern American culture.

The University conducts a number of cultural activities for students, faculty, and the rest of the Austin community. Among these are concerts, dramatic programs, and artistic exhibitions provided through the College of Fine Arts and the Cultural Entertainment Committee of the Texas Union.

Located about 80 miles southeast of Austin, the University's Winedale Properties in Fayette County near Round Top are an outdoor museum of Nineteenth Century Texas cultural history on a 190-acre tract. Museums on campus include a variety of permanent and raveling exhibits and displays, among them the Texas Memorial Museum's 50-foot prehistoric pterodactyl.

Some of the most impressive expansion at the University has been in science and engineering. The science and engineering laboratories of the Balcones Research Center in northwest Austin house a variety of projects. The Bee Cave Research Center seven miles west of the city is used for astronomy teaching and research, electrical engineering research, and other research and training activities. And a portion of the 444-acre Brackenridge Tract along Town Lake is occupied by a field laboratory for research in zoology, botany, and biology.

Several University teaching and research units are located many miles from the Austin campus. The UT Marine Science Institute has facilities at Port Aransas and Galveston on the Gulf of Mexico, where it conducts fundamental research on the physical, chemical, and biological processes occurring in the waters and along the shores of the Gulf coastal zone. The institute also provides upper division and graduate level courses in the marine sciences.

Taking advantage of the high altitude and dry atmosphere of the Davis Mountains in West Texas, McDonald Observatory is engaged in space and solar system studies in association with the UT Austin Department of Astronomy. The observatory has four optical telescopes, including one of the world's largest reflecting telescopes (107 inches).

Located on the grounds of McDonald Observatory, UT's Radio Astronomy Observatory maps radio sources outside the galaxy and observes radio emissions from the planet Jupiter. Currently, the major effort is directed toward precisely locating 50,000 radio sources and providing a basic reference for radio astronomers around the world. The Radio Astronomy Observatory is under the direction of the Electrical Engineering Research Laboratory.

Energy Education, Research, and Public Service

Energy research, education, and public service have been important concerns of The University of Texas at Austin since the establishment of the Bureau of Economic Geology in 1913. Over the years, this quasi-state agency, which also functions as the State Geological Survey, has published over 800 papers dealing with the location and use of Texas's natural resources. Today, the Bureau is conducting extensive energy research programs in oil and gas, coal, lignite, uranium, and geothermal resources, as well as land-use and environmental analysis.

As early as 1924, the Department of Chemical Engineering began looking into more efficient ways to gasify lignite and coal; by the late 1930's Dr. E. P. Schoch, Chairman of the Chemical Engineering Department, was already well known for his development of methods for using natural gas as a basis for fertilizers and petrochemicals.

As the principal monitor of the state's business and economic climate for fifty years, the Bureau of Business Research has conducted extensive research and analysis of both the energy aspect of business and the business aspect of energy. Since Texas both produces and consumes more energy than any other state in the United States, it is a particularly appropriate model for such studies.

The University's Population Research Center and Department of Sociology have conducted work on the sociological and demographic aspects of energy. And since energy is so critically involved in almost all governmental policy, the Lyndon B. Johnson School of Public Affairs has devoted considerable effort to energy public policy analysis.

In 1947 the University's Board of Regents and Texas A&M's Board of Directors founded the Texas Petroleum Research Committee (TPRC), the research arm of the Texas Railroad Commission. Working together over the years on TPRC projects, UT Austin and A&M have made considerable advances, particularly in the areas of enhanced recovery techniques and improved production efficiency. Much of this research has been conducted by members of UT's internationally acclaimed Department of Petroleum Engineering.

Since its founding ten years ago, the University's Fusion Research Center (FRC) has established a worldwide reputation. As one of only two major university-based centers with active experimental programs in the United States, it has a staff of plasma theoreticians and experimentalists who are recognized internationally as the best in their field. Working with the Texas Tokamak fusion experiment, UT scientists have achieved the highest temperatures ever recorded in an experimental plasma. The FRC's engineering team is making significant strides in developing ways to reduce the high cost of very large fusion experiments.

As national and international energy concerns became more pressing and complex, the University recognized the need for an organization that could serve as a focus for interdisciplinary energy research and policy development, so in 1974 it established the Center for Energy Studies (CES). Operating under the broad-based guidance of an Advisory Board which includes the deans of seven colleges and schools and a University assistant

vice-president, CES conducts research in the technical, sociological, and policy-development aspects of the major energy supply and demand systems. The Center is also investigating ways to decrease inefficiencies in residential, industrial, and commercial energy use.

Some 40 faculty members are involved in CES projects, along with more than 35 full- and part-time staff, whose backgrounds range from engineering to marketing to communications. The goals of CES are to encourage energy-related research, to promote energy educational activities, and to provide public service in the energy area.

The most active Center for Energy Studies program to date has been an interdisciplinary study of the Texas Gulf Coast geopressured geothermal resource. This multimillion dollar project combines CES efforts with those of the Bureau of Economic Geology, the Department of Sociology, and the Departments of Petroleum and Mechanical Engineering. Experts estimate that these geopressured geothermal deposits may be capable of producing between 20,000 and 70,000 megawatts of power over a 50-year period. Yet, before this resource can be proven economically feasible, researchers must determine the best drilling and surface technologies. Furthermore, there are serious legal, environmental, and institutional constraints that must be overcome.

One of the most innovative programs currently under way at CES is the development and use of computer simulation models for energy policy analysis and forecasting. Current policy analysis models in use by CES policy assessment teams include the Mathematical Programming Model of World Oil Supply and Demand, the Multisectoral Model of the U.S. Economy, and the Regionalized Electricity Model, generally recognized as among the most sophisticated energy models available.

International Education

For more than a generation, The University of Texas at Austin has been a leader in international scholarship. Current students and faculty represent more than 90 countries and every continent. UT students are encouraged to take part in exchange programs and studies abroad. A variety of international studies programs bring each region's language, culture, politics, and history together as a single academic discipline.

The University's International Office acts as a focal point for much of this activity. As the senior operation of its type in the United States and a prototype for similar services on other campuses, the International Office has been under the direction of Dr. Joe W. Neal since its inception in 1941.

During its 35-year history, the International Office has been responsible for advising and assisting approximately 9,000 international students, of whom 2,000 are currently enrolled at the University. The Office corresponds with international students before they arrive, helps with admission procedures, assists in securing financial aid, counsels them on their academic careers, provides intensive English programs, serves as an intermediary and representative of sponsors, and lends guidance with field trips, vacation plans, and immigration regulations.

Working closely with the International Office since 1950, the International Hospitality Committee of Austin provides additional services for UT international students. Hospitality Committee programs include finding host families, arranging community visits and field trips, and conducting English language programs for spouses.

The International Office has been involved with international programs in countries all over the world under the sponsorship of national and international agencies and foundations. The Office was one of the participating organizations in the International Ex-Students' Conference on Energy and was also a sponsor of the 1970 International Ex-Students' Conference. Dr. Neal maintains contacts around the globe through an extensive program of international travel and correspondence.

A variety of exchange programs allow United States students at the University to study other countries firsthand. UT Austin currently has formal programs in Africa, India, Brazil, Peru, Chile, and other areas. The University also sponsors a Management Education Program for French Educators in Austin.

Over the years, The University of Texas at Austin has become increasingly noted for its international studies programs conducted under the Division of General and Comparative Studies. The broadest of these interdisciplinary pursuits is actually called International Studies. Although it is not a major field of study itself, it encompasses international law, politics, education, sociology, history, and other topics as upper division supplements to a major field.

The Center for Middle Eastern Studies focuses on contemporary social, economic, and political conditions in the Middle East. It offers a variety of undergraduate and graduate courses and programs in Middle Eastern languages, arts and letters, and social sciences concentrating on Arabic, Hebrew, Persian, and Turkish cultures and civilizations. In addition, the

Center conducts programs in the field which give faculty and advanced students opportunities for study in the various countries of the Middle East.

The University of Texas Center for Asian Studies is dedicated to leading undergraduate and graduate students to a greater understanding of the cultures of Asia, so that they will be able to relate meaningfully as scholars, diplomats, and business and professional people to those who comprise more than half the world's population. Many of the undergraduate courses are open to nonmajors who consider a knowledge of Asian civilization essential to a contemporary liberal arts education.

The Center for European Studies offers undergraduate students a concentration in West European Studies, East European Studies, or a combination of both. The program is designed to complement departmental specialization with an integrated sequence of courses which emphasizes a multidisciplinary approach to modern European history, politics, and culture.

Founded some 35 years ago, the Institute of Latin American Studies offers the oldest and largest interdisciplinary program on the University campus and is one of the earliest organizations of its type in the United States. Over the years, the Institute's combination of faculty, facilities, and organization have made it one of the half dozen major centers for Latin American scholarship in the country. The University's Nettie Lee Benson Latin American Collection has received international notice as one of the finest collections of its type in the world. Containing some 300,000 volumes, 900,000 pages of manuscripts, 3000 bound volumes of newspapers, and numerous maps, photographs, and reels of microfilm, the Collection contains materials from every country in Central and South America and the Caribbean. It occupies 65,000 square feet in Sid W. Richardson Hall.

Alumni Activities

While many of the University's schools, colleges, and individual departments communicate with their alumni and provide continuing education programs and other services, most UT Austin alumni activities center around the Ex-Students' Association.

Founded in 1885 by members of the University's first graduating class, the Ex-Students' Association has dedicated itself to the dual purpose of serving the University and promoting fellowship among UT Austin alumni throughout the world. The diversity of the Association's programs reflects the varied interests of more than 250,000 alumni both here in the United States and abroad.

Alumni activities begin on the UT Austin campus and spread out to encompass most of the globe. At home, the Ex-Students' Association has raised funds for the construction of several UT Austin buildings, including the Memorial Stadium, Gregory Gymnasium, the Anna Hiss Gymnasium, the Texas Union, and the Lila B. Etter Alumni Center. It was also directly responsible for the location of the Texas Memorial Museum on the University campus.

The Association also provides scholarships, internships, and career assistance, as well as athletic recognition, to University students.

On an international scale, the award-winning bimonthly magazine *Alcalde* keeps Association members around the world informed of alumni activities and campus events and changes. Every year the Ex-Students' Association hosts a Christmas party for those foreign national students and their families who are spending the holidays in Austin.

For the past 17 years, the Association has enabled alumni to travel to every continent through Flying Longhorn Tours. These tours offer far more than the economy of charter flights. They give alumni a glimpse of the people and cultures with which they come into contact, sometimes through native guides, sometimes through accompanying faculty experts in the archeology, anthropology, art, or history of the area.

Each fall the Ex-Students' Association recognizes the extraordinary accomplishments of University alumni through the Distinguished Alumnus Awards. A number of the recipients of this honor have been foreign national alumni, including Mexican journalist Ramon Beteta, former President of Peru Fernando Belaunde-Terry, Mexican engineer Luis Flores-Arias, Mexican lawyer and financier Miguel R. Cardenas, and Mexican industrialist Mauricio B. Madero. Three of the speakers at this conference—former Chairman of the Board of General Foods C. W. (Tex) Cook, former Ambassador to Australia and UT Regent Edward A. Clark, and journalist and Pulitzer Prize winner William S. White—are also Distinguished Alumni. UT Austin President Lorene Rogers is scheduled to receive the award in 1976.

Perhaps the most important international activity of the Ex-Students' Association is participating in international ex-students' conferences, such as the Conference on Energy. The first such conference, held in 1970, was so successful that the participants felt that a similar event should occur every five years. The present conference was postponed until 1976 to allow

international participants to enjoy the United States Bicentennial Celebration in conjunction with their trip to the Conference.

The University hopes that these conferences serve not only to promote fellowship among international alumni, but also to strengthen world understanding.

NASA Visit

by Mr. Jim Hicks, News and Information Service, The University of Texas at Austin

Almost 70 participants in the International Ex-Students' Conference on Energy at The University of Texas at Austin visited NASA's Johnson Space Center on Monday, April 26, 1976.

Dr. Chris Kraft, director of the Johnson Space Center, officially welcomed the visitors to the center, and then NASA officials briefed them on current NASA research activities including Space Shuttle, earth resource survey by remote sensing, and the design of energy-conserving communities.

Space Shuttle is the nation's first re-usable space vehicle and will allow man actually to use space for the first time rather than be a visitor. Activities scheduled for Space Shuttle include astronomical observatories, earth resource surveys, and exotic manufacturing techniques which require zero gravity.

Emphasizing that NASA data are available to anyone, a spokesman demonstrated how remote sensing techniques using satellite data can locate mineral resources and identify not only specific crops but also those which are healthy and those which are suffering from blight or drought.

Under a contract from the U.S. Department of Housing and Urban Development, NASA has designed a community which consists of housing units organized around central utility facilities which provide water, sewage, electricity, and trash disposal.

Energy savings are realized by such techniques as recycling heat produced by trash burning.

According to a spokesman, "we at NASA were especially qualified for the design of self-contained energy-efficient units because each of our manned spacecraft was independent, and by necessity highly efficient."

Current costs are too high to make it competitive with present sources of energy, but one NASA plan for the future may become feasible if energy costs continue to climb and the cost of lifting hardware into orbit continues to decrease.

NASA scientists envision satellites with solar collector areas of several square miles which can convert the sun's energy to microwaves and transmit them to the earth for re-conversion to electricity.

Advantages of the system include lack of interference by clouds and the fact that satellites would be placed in geosynchronous orbits which will always be in the sunshine, and therefore energy storage systems would not be needed at night.

Afternoon activities included a briefing in mission control from which all aspects of space flight—from a few seconds after lift-off in Florida to splashdown—are controlled.

A tour of a full-scale mock-up of Skylab, used for astronaut training, demonstrated problems and the clever solutions of such routine activities as eating, bathing, and tending to other personal hygiene chores.

Conference Opening Session

Dr. Lorene L. Rogers
President of The University of Texas at Austin

Mr. Wales Madden, Jr.
President of the Ex-Students' Association

The Honorable Edward A. Clark
Chairman of Conference Steering Committee

Dr. Lorene Rogers
President of The University of Texas at Austin

Ladies and Gentlemen:

It's a distinct privilege and pleasure to be able to welcome each of you on behalf of the whole university community to this International Ex-Students' Conference on Energy. We are especially gratified that so many distinguished individuals chose to come and participate in this conference. We want to extend an especially cordial welcome to those ex-students who have come back to their university from some 40 countries throughout the world to take part in this momentous event. Your presence here indicates your continuing loyalty to this institution and we are pleased to dedicate this conference to you. Many of you will remember and some of you participated in the 1st International Ex-Students' Conference which was held on this campus five years ago. We thought that was a very successful reunion of our international ex-students, and you were so pleased with it that you asked us to have another one within five years. When we started planning this conference, we could think of no subject which was more appropriate to be discussed while you were here than energy, the crisis that we now face, the problems that are before all of us. Many of you came here to this institution because you wanted to study petroleum technology and learn something about the production and distribution of energy. You have now become experts and we seek your knowledge and your advice.

We chose energy as a subject partly because of the great importance that it has for all of us. Perhaps no event since World War II has had such an effect on the political, economic, social, and environmental outlook of nations as the energy crisis that seemed to fall upon us full blown almost three years ago. Of course, the

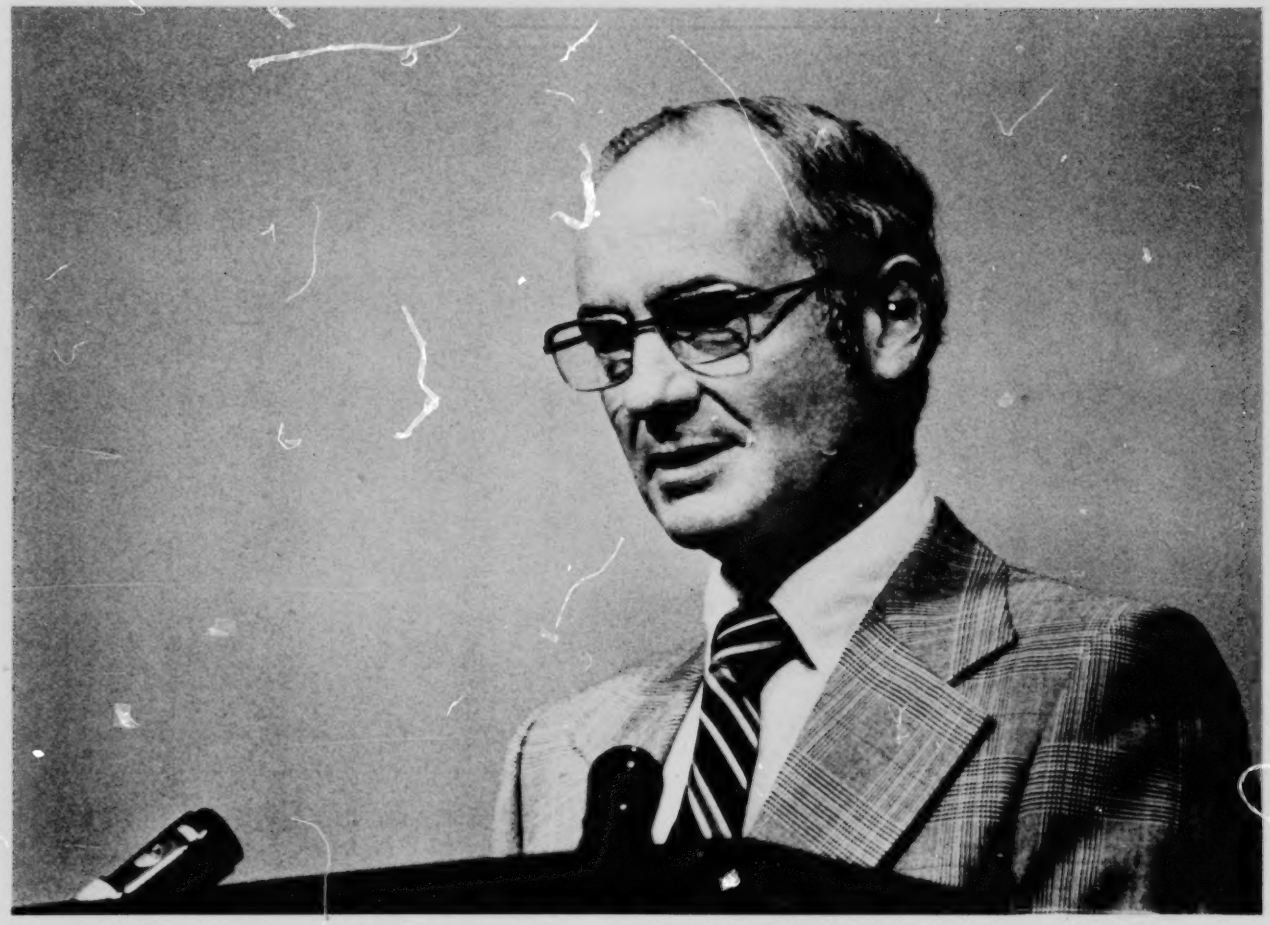
crisis and the problem did not start then and some people recognized this was coming many years ago. One of the people who recognized it quite early was one of our famous professors, Dr. E. P. Schoch. I can remember in the 40's that Dr. Schoch was saying you will see the time when the gas pipelines that are now carrying natural gas from Texas to the East Coast will be used to bring liquefied coal gas back down to Texas from the Pennsylvania coal fields. One of his successors and one who now bears the name of the E. P. Schoch Professor, Dr. John McKetta, who is on the stage this morning and will be talking with you, has been giving that same message the past several years to any audience that he could get to listen. So it is an important problem, and one for which we must find solutions.

Another reason that we chose this subject is that we in this university have made great contributions and are still making great contributions to the solution of this problem. We have research going on in many areas of this campus, many departments seeking new energy sources, seeking better methods of distribution, seeking ways to conserve the energy that we now have. Because all of these problems do not fit neatly into one academic area or the other, we created on this campus a couple of years ago a Center for Energy Studies, and it is entirely appropriate that that center should help co-sponsor this conference to which you've been invited. We will continue to do what we can as a university to contribute to the solution of this as well as other problems that face mankind.

We have still a third reason for asking you back here, though, one that is less serious than the ones that I just talked about. That purpose is to bring you together again to renew friendships and acquaintances with the people you knew when you were a student here on this campus. We hope that you will spend some time seeing the new buildings that have gone up since you were here, visiting this great presidential library where we are sitting now, strolling on the campus trying to identify some of the spots that you knew, talking about professors, bull sessions, falls and springs that you spent here, and perhaps talking about coeducational dormitories which when you were here seemed as remote as the oil crisis.

I want to pay tribute to the people who have had a part in it. We have had a steering committee made up of prominent individuals over the nation with an interest in this area and who have great devotion to this university, and they have been of great help to us. There are many industrial concerns who supported us financially to make this conference a reality. There was a planning committee on this campus and they have spent untold amounts of time getting ready for this. Among the people who have contributed greatly in time and effort are: Dr. Herbert Woodson, and you'll hear from him later in the morning, he is the director of the Center for Energy Studies; Mr. Roy Vaughan who is the director of the Ex-Students' Association; Jack Maguire who until January of this year was the director of the Ex-Students' Association; Dr. Joe Neal who is head of the International Office on this campus; Dr. Floyd Brandt who is an assistant to the president; and Clif Drummond who is Director of Liaison in the Center for Energy Studies. That's only a beginning list, but those people have made great contributions of their own time. Now there's one other person who also is on stage and I must talk about him because he too has made great contributions. That is the former Ambassador to Australia and now regent of the university, Mr. Ed Clark. If it had not been for his interest and his time and his financial support, I am certain that the conference would never have seen the light of day. The remaining person that I want to mention by name will also be giving a welcome to you, and this is Mr. Wales Madden who is President of the Ex-Students' Association. Mr. Madden . . .

Mr. Wales Madden, Jr.
President of the Ex-Students' Association



Thank you Dr. Rogers. Being privileged to follow such a petite and cute redhead has its disadvantages, because I'm now standing on the podium which she stood upon and I'm not sure how high I am and whether or not I can be heard. I guess the mikes are keyed for any height. University alumni are visibly prominent in the development of energy throughout the world. Ex-students will be eminently involved in producing solutions to the complex problems facing the people of the world who must have energy for survival. That its progeny will be so involved is a lasting tribute to this University of Texas. The Ex-Students' Association exists in part to provide a forum for a dialogue between the intellect of the academic, the practicality of the alumni, and the dreams of the students. We enthusiastically accept the role as we cosponsor this conference which must be destined to remove the bumps along the road of mutual understanding. If bumps are eradicated and a community of respect between the producing and consuming nations emerges, then solutions to the problems will evolve. How exciting it is to have a role in this significant effort. How proud we are to welcome our friends, visitors, and alumni back to the university, and how pleased I am to present to you the man who first conceived the idea of the conference. Lawyer, banker, regent, former ambassador, and citizen extraordinaire, the Honorable Edward Clark of St. Augustine, Texas. Mr. Clark . . .

The Honorable Edward A. Clark
Chairman of Conference Steering Committee

Dr. Rogers, Mr. Madden, my friends:

The University of Texas has long been blessed with the most able talent in energy research and energy education. At present, the University has internationally recognized programs in nuclear energy—both fission and fusion—in oil and gas discovery and recovery—in electrical power production, storage, and transmission—in energy conservation—in economic and sociocultural analysis—in new fuels development—and most recently, in the challenging new area of geothermal energy feasibility. The impression which is gendered by these vital research programs will be the nucleus around which this conference will revolve.

As part of the more than 9,000 foreign national alumni of this great institution, you reflect the epitome in energy expertise. You have before you a once-in-a-lifetime chance to reestablish the common ties of all UT ex-students, and for an almost overwhelming higher purpose: This week you will be afforded the opportunity to help write *world* history as you come to grips with the most critical issue ever to face our planet.

Each one of you can provide a totally unique impetus to the achievement of this goal. You will hear in the next few days addresses from some of the finest minds in the energy field. These will be no dry academic lectures or pedantic expositions of philosophy. There *will* be heard words which will demand your *total* attention—ideas which can consume your entire being.

As with any *good* gathering of persons having such strong common bonds, this conference will promote a no-holds-barred exchange of ideas. I encourage each and every one of you—be you UT alumni, faculty, bus-

iness representative, or simply and most dramatically *world citizen*—to *react* to what you will hear in the next few days.

Let everyone here feel no restraints to speak his or her mind regarding *all* issues which are discussed. You have an inherent right to do this because the business we will conduct here is *everyone's business*—from the individual struggling to pay the monthly utility bill—to the city council agonizing over the best way to serve its constituents—to the Board of Regents which must manage vast energy holdings for the best educational benefit of the most number of people—to the state government representatives striving to maintain a proper balance between a state's independence and the duty to serve a broader national interest—to the federal government which recognizes the often-competing responsibilities of regulating energy production and use, preserving a stable economic and sociocultural climate, and attempting to exist in peace and fairness with the other nation-states of the world.

And finally, that brings us to the reason we are all here today: Every area I have mentioned is repeated in varying degrees of magnitude in every other country around the world . . . and that means these concerns are the concerns of more than *4 billion* people.

This is not only a problem which won't go away by itself—it's a problem which we must do something about NOW . . . HERE . . . with every ounce of talent we collectively possess.

I exhort you to LISTEN to the speeches—REACT to the speakers—and INTERACT with each other. And above all, never forget WHY we are here and what magnificent solutions can be wrought from our mutual cooperation. I thank you, very much.

The Keynote Address: Energy, In Search of a Policy

The Honorable Gerald L. Parsky
Assistant U.S. Secretary of the Treasury

Discussion

Energy, In Search of a Policy

The Honorable Gerald L. Parsky
Assistant Secretary of the Treasury

It is indeed an honor to be at The University of Texas at Austin for the International Ex-Students' Conference on Energy. A half-century ago, Winston Churchill observed that in happier times it was the custom for statesmen to "rejoice about that protecting Providence which had preserved us through so many dangers and brought us at last into a secure and prosperous age." But "little did they know," Churchill wrote, "that the worst perils had still to be encountered, and the greatest triumphs had yet to be won."

The same may be said of our age. The United States is at the end of three decades of a foreign and domestic policy which, on the whole, has brought peace and prosperity to most of the world and which was conducted by leaders from both of our major parties. Inevitably, there were failures, but on the whole they were dwarfed by the long-term accomplishments.

Now, we are entering a new era. The world has become interdependent in economics, in communications, and in human aspirations. No one nation, no one part of the world, can prosper or be secure in isolation. For America, involvement in world affairs is no longer an act of choice, but the expression of reality. When weapons span continents in minutes, our security is bound up with world security. When our factories and farms and our financial strength are so closely linked with other countries, our prosperity is tied to world prosperity.

Some would fear this interdependence; I believe we should not. Instead, I believe we must accept it and through leadership by the United States, we should build on it. Underlying all of the problems we face—whether it be achieving economic prosperity, or building a constructive relationship with the developing na-

tions, or ensuring the economic security of our own country—is the need for world cooperation and leadership. In this process, we in the United States must not be afraid to stand up for economic principles we believe are right. Our country has been built in a market-oriented system—a system that is reliant on the private sector as the propellant to our development. Recently, however, this system has come under increasing attack from those who would have government take on a greater role in regulating or controlling all aspects of our lives. Confidence in the ability of U.S. business to compete freely for the benefit of all, with the minimum of government intervention, has been seriously weakened. Instead we are tempted to turn more and more to the government to solve our problems at whatever cost—either to our pocketbooks or more importantly, to our freedoms.

Probably the most glaring illustration of what I am saying is the way in which we have failed to sense the proper direction for energy policy. Of all the issues we face, none is more basic to the future than the challenge of energy. If we let the past dictate the path for the future, we will surely fail, and if we fail, the world will suffer.

So many experts warned us again and again that our energy demands were growing faster than our supplies. However, rather than allow the private sector to meet this challenge—as it can and would—the government has erected one impediment after another.

Now, crude oil and petroleum products remain the only commodities not released from the old price control system. Imagine—in an area where we need policies that will encourage the development of additional supplies, we have continually refused to recognize what needs to be done. It may sound politically appealing to say that prices will be rolled back and kept down, but aren't we only fooling the American people? The only thing such controls will do is to prevent the increased exploration and production necessary to give us the ability for self-sufficiency in energy. Since August 15, 1971, when price controls were first instituted, crude oil production has declined. In 1971, it was approximately 9.5 million barrels per day. Production in 1975 averaged 8.4 million barrels per day—a decline of about 700,000 barrels per day from the time of the embargo and about 13 percent from peak production in 1970. One of the major reasons this occurred is that the government has continued to interfere with the functioning of the market, and private sector uncertainty makes it impossible to commit the increasing amounts of capital needed to find and develop new resources.

What should we be doing? Our goal is to reduce our vulnerability to a cutoff in supply. Right now, we are moving in the opposite direction; for about 42 percent of current U.S. petroleum demand is being provided by imports. In fact, in March, crude oil and product imports briefly exceeded domestic production for the first time.

What should our policy be? Perhaps we should start by stating what our goals should not be:

—We *should not* be seeking zero imports. We can eliminate vulnerability through diversifying supply, storage, and taking other emergency measures.

—Our objective *should not* be to destroy OPEC through the creation of a politically oriented countercartel.

—We *should not* be pursuing a policy of confrontation with OPEC, calling for embargoes or counter-embargoes. Such statements may have political appeal, but such an embargo would not be effective, and in my mind would be counter-productive to our long-term goals.

—Our objective *should not* be to negotiate a world price for oil. Not only are we not in a position to determine a "reasonable" price, but more importantly, it would only be a move toward more governmental control over the industry.

Instead, we should be striving to create the objective conditions which will bring about an expanding supply of energy at market prices. Notice that I said "market prices"—we should not be seeking to shift price decisions from one set of governments to another, but rather to take steps that will ensure that the market can set the price for oil.

It's clear to all of us that the oil-producing countries currently have the ability to set the price for oil. I believe that no matter what we do, OPEC will retain this control for the remainder of this decade. If we don't adopt a sensible energy policy now, OPEC's control will continue well beyond the 70's. We do have the resources to provide adequate alternatives beyond 1980. Just looking at the new North Slope and Outer Continental Shelf, they could yield 3 to 4 million barrels per day. If you consider the North Sea, Mexico, and

Malaysia, the potential is enormous. Already in 1976, oil output in non-OPEC countries should rise 500,000 barrels per day from 16.5 to 17 million barrels per day. By 1980, non-OPEC oil production will rise to over 20 million barrels per day. This figure does not include the communist countries. With this potential in mind, the approach that is needed involves three parts—a comprehensive U.S. energy policy, cooperation with other oil-consuming countries, and cooperation with oil-producing countries. Let's look briefly at each of these.

U.S. Energy Policy

Unfortunately, the United States has been without a comprehensive energy policy for too long. If we hope to remove our current vulnerability, we must face some fundamental facts. If there is a major lesson to be learned from our past energy policies, or the lack of them, it is that a system of patchwork government regulations and short-run measures designed to head off specific crises leads to more patchwork regulations and short measures—not to a viable energy policy that will produce energy efficiently at the lowest prices to consumers.

The President has established clear-cut goals to increase our domestic energy supplies and reduce imports, including:

—An energy conservation program to reduce energy demand by the equivalent of 3 million barrels a day, reducing the annual energy growth rate to 2.2 percent through 1985.

—An increase in crude production from 8.4 million barrels a day to about 12.3 million barrels a day by 1985.

—An increase in natural gas production to more than 22 trillion cubic feet by 1985 as compared to the 20 trillion cubic feet total produced in 1975.

—An increase in coal production from 640 million tons in 1975 to over 1 billion tons by 1985.

—An increase in nuclear power's share of electric power generation to about 26 percent by 1985 compared to 1975's 8.6 percent, and

—An expanded commercial demonstration effort for synthetic fuels technologies must be in place by 1985.

I believe these goals set forth by the President are sound; but the government cannot achieve them. It's only the private sector that can do it; for it will take significant capital investment to develop this energy. We estimate that investments of about $580 billion (1975 dollars) will have to be made between now and 1985. While this investment seems large, it is only about 30 percent of the anticipated overall level of business fixed investment in this period, which has been energy's historical share. However, investments for energy conservation and for increased energy efficiency could also be significant—perhaps an additional $250 billion through 1985. Our capital markets will have the capacity to meet the external financing needed for these energy investments. The important question is whether capital will actually flow to these energy projects rather than alternative uses. To ensure this flow, the energy industry must be able to earn competitive returns on its investments free of unnecessary controls, particularly controls which artificially hold energy prices below their competitive market levels.

The President is committed to ensuring an energy policy that will achieve our goals. In January 1975, he submitted a set of measures to Congress that would do just that. The energy bill that evolved during the year was not the same bill. It does contain important steps in the right direction, but the penalty for ultimately ending oil decontrol is first to roll back the average oil price. This action could not help but have a retarding effect on exploration and development. Nevertheless, the President is committed to bringing about decontrol as rapidly as possible, and we must make sure that this happens and that the 40-month period for decontrol is not extended.

This legislation is certainly not the end of our efforts to bring about a more rational energy policy.

Prices of our natural gas are still prohibited from rising to their market level in interstate markets, and shortages will continually plague us unless price is allowed to rise. Domestic marketed natural gas production has declined by approximately 11 percent in the last two years—a trend that must be reversed.

It seems that we still have not fully grasped the lesson of our past policies—that no individual or group of individuals can allocate resources more efficiently than the marketplace. Of course, we recognize that a "pure" free market for oil is fantasy as long as OPEC controls as much supply as it does. But we can still choose between policies that move us further from government control and closer to an operational market or policies that will strengthen government interference. From

where I stand, the choice is clear. The only way to solve our energy problems over the long term is to adopt rational, predictable energy policies that can turn over the direction of resource allocation to the marketplace and to the underlying forces of supply, demand, and price.

Unfortunately, not everyone in this country agrees with this approach. Recently, there has been a movement in the Congress to break up our energy companies by prohibiting them from engaging in more than one level of the oil industry, or from engaging in more than one energy-related activity. Here again, political considerations are distorting economic realities.

Our efforts to increase our energy supplies and reduce our vulnerability to import cutoffs are hampered by threats of divestiture of a major segment of our petroleum industry. Such threats have created uncertainties which will adversely affect investments in the petroleum industry, and which will ultimately be manifested in reduced domestic energy supplies.

The rhetoric of divestiture is couched in terms of enhancing competition. For example, the preamble to one of the recent bills finds that "existing antitrust laws have been inadequate to maintain and restore effective competition in the petroleum industry." So it is proposed that the laws be changed "to require the separation and divestment of assets and interest by vertically integrated major petroleum companies." Another bill is designed to "create competition in the petroleum industry, thereby breaking the economic stranglehold of monopoly power" and "to prevent in advance the aggrandizement of monopoly power over alternative domestic sources of energy."

We should not forget that we have antitrust laws specifically designed to handle such problems on an industry by industry basis. But to read the preambles of most of the recently introduced energy divestiture legislation, you would not think so. These bills collectively imply that our antitrust agencies cannot find sufficient evidence of monopoly power in the oil industry to bring a national antitrust complaint under our existing antitrust laws—so Congress needs to change the law. In effect, they want to legislate a guilty verdict and a harsh penalty without trial.

This type of incursion into our economic freedom is serious enough—but to pursue such a course in a critical industry, such as the energy industry, at a time when shortages already exist, makes bad policy even worse.

The real question is whether any benefits that might be derived from divestiture outweigh the costs. No one who supports divestiture has produced evidence that it will benefit the consumer. I would expect, on the contrary, much of the legislation would prove costly to the consumer and to the advancement of our energy goals.

We in the Treasury Department are now in the process of making an assessment of the impact of divestiture and, in particular, the impact on the industry's ability to raise the capital necessary to meet the President's energy goals.

Our preliminary assessment indicates that divestiture will seriously hamper the ability of much of the industry to obtain financing in an efficient manner. The great financial, economic, and legal uncertainties associated with implementing divestiture would adversely impact the ability of all affected companies to attract new external debt capital. For some companies, the capital markets could be effectively closed until these uncertainties are resolved. Existing lenders would face a situation in which the nature of their original investments in integrated oil companies was radically altered. Should the affected companies be forced by the divestiture requirements to violate the covenants of existing loan agreements, many of which prohibit the spinoff of substantial portions of a company's assets, lenders could put great pressure on the companies to repay the debt over the shortest feasible time period. Were this to happen, it would substantially strain the available financial resources of these firms.

In addition to our concerns about financing, our assessment has further indicated that vertical and horizontal divestiture would have unfavorable transitional and long-term effects on our petroleum industry. These effects include lower output, upward pressure on prices, and significant adjustment problems in our international transactions. There is also a significant danger of increased reliance upon foreign petroleum sources.

With so many different possible approaches to divestiture, it is important to consider the specifics of any proposal before passing final judgment, and we will certainly do this. However, I would urge that we move the focus away from what may sound politically attractive today to what we know will be economically sound for tomorrow.

We need energy and we need energy innovation. Both are extremely expensive to undertake and both involve substantial risks. The twenty largest U.S. oil companies rank highest among the U.S. concerns with the expertise to help us solve our energy problem. If we want more exploration and production, if we want additional refining capacity, if we want pipeline transportation facilities, if we want research on nuclear energy, geothermal energy, coal gasification, oil shale, and other energy sources, we will have to look to the private sector; and the private sector will respond if it believes that it will receive a certain and adequate return. For this to happen, we have to begin to speak out against government intervention. The only way we will get our own energy house in order is if we stop handicapping business initiative.

Cooperation with Oil Consumers

At the same time that we must strive for a strong U.S. energy policy, we should be working for greater cooperation among consuming countries.

The Administration has already made substantial progress in this area. During the past year we have developed cooperative programs with our International Energy Agency (IEA) partners with respect to emergency oil sharing, conservation, research and development, and accelerated development of alternative energy sources.

Through the emergency oil-sharing agreement, we have been able to provide sensible, contingency protection against another embargo. In conservation, we have developed mutual conservation targets and a program of annual conservation reviews to help nations identify the nature and source of their conservation progress. Although we must be watchful of the costs of conservation, until additional supplies of world oil and oil substitutes can be brought on stream, conservation is our best hope for reducing our joint dependency on OPEC oil.

As in the case of energy conservation, our accelerated energy resource development program has an annual review. Its purpose is to enhance national understanding among IEA members of the energy development strategies being followed by each. Moreover, it serves to increase our mutual information flow so that energy development strategies which seem to work in one nation can be brought rapidly to the attention of others for their evaluation. Research and development is another area in which joint cooperative efforts among International Energy Agency members can have a potentially high payoff. Pooling our intellectual resources in this area could mean more efficient interfuel substitution, advanced and less costly fission reactor systems, or even fusion technology, well before one country could achieve such objectives alone.

There are a number of possible cooperative measures that can be taken in the R&D area. Some have already been agreed upon and will be implemented under the recently approved long-term cooperative program. These include the exchange of information, mutual assistance in developing R&D strategies, and discussion of what can be done to eliminate overlapping efforts and assure adequate coverage of all energy production and conservation possibilities. Still others are being actively discussed within the context of the International Energy Agency at the present time. These include large-scale cooperative projects in long lead time or back up technology which no country could efficiently engage in on its own.

As I have said, these and other efforts by consumers should not be viewed as a means of confronting OPEC. In fact, the objectives of such cooperation are not contrary to OPEC's; as such, I believe we should seek OPEC's participation in helping to achieve them.

Cooperation with Oil Producers

In this regard, and across the whole spectrum of economic issues, we must seek greater cooperation with the oil producers. This is the essential third element in a comprehensive energy policy; and if we fail to realize it, our whole policy will fail. Although producers and consumers have different views on oil prices, there are many interests that are complementary, and we should aim to develop our common interests. For instance:

—To convert their financial resources into goods, the oil-producing countries are looking to the consuming nations. OPEC is the fastest growing market for exports and there are economic benefits to be derived by the consumers.

—To convert their goods into new non-oil industries, the oil producers want consumer country technical and managerial skills.

—To assure the viability of new non-oil industries, oil-producing countries will need markets. These will

require stable trade regimes and we can all gain through negotiating sound commercial arrangements.

—To assure the profitable investment of surplus funds, oil exporters are looking to consuming country capital markets. It is in our interest to maintain the freedom of those markets.

The markets for OPEC oil and other exports, the cost and availability of the goods they import, and the value and security of their foreign investments all depend on stable, non-inflationary growth in the world economy and a stable international financial system. The oil-exporting countries' economies are thus necessarily closely interdependent with the economies of the oil consumers.

It is these mutual interests that I feel we should build on. As we do so, I feel that greater understanding can be achieved concerning oil prices. In order for this to happen, both consumers and producers must understand each others' needs:

—Consumers must understand the legitimate desires of the producers for diversification of their economies and for higher standards of living for their population, and

—Producers must understand that the rapid rise in oil prices has placed a great economic burden on all consuming nations, developed and developing alike.

Conclusion

Tonight I have discussed our efforts to develop and coordinate national and international energy policies. Our efforts have been hampered by ever-increasing governmental interference. Such actions involve short-term political objectives which will lead to policies completely counter to our long-term economic goals.

The Arab Oil Embargo of 1973–74 woke us all up to how vulnerable we are. The time is long overdue for this country to establish a long-term national energy program and to embark upon its implementation. At the same time, we must transform this domestic approach into an international policy. The President is committed to doing just that; but the process of making policy is not a unilateral one—it comes from the collective will of the Executive Branch, the Legislative Branch, and the people. What we need now are more people who are willing to stand up for what they know to be economically right. That's why a conference like this is so important; hopefully you can leave these sessions with a better understanding of the dangerous path we have been on and the need for a new direction.

The United States has the resources to provide adequate energy beyond 1980; but to develop this energy we must move forward with a comprehensive energy policy in which political considerations are not allowed to distort economic realities.

A famous novelist once said, "The web of this world is woven of necessity and chance." We stand at a point where those strands intertwine. We must not regard necessity as capricious, nor leave change to chance. In the past, we have drifted, and we are still in search of an energy policy. Now, we must decide. We have it in our power to build a better future, and we must not be satisfied until we have adopted policies that ensure that this will happen.

Discussion

Parsky: I indicated if anyone has any questions either about the remarks I've made or about what is happening in Washington, I'd be delighted to try to answer them.

Question: After listening to your very impressive curriculum vitae, I think we could even ask you how to increase production of coffee in Colombia. But this question has to do also with Colombia in this particular case. About two months ago a tanker sank off the coast of Colombia with 300,000 barrels of oil. It is still down there, and unfortunately we don't have the luxury of government advisors as you do in this country. The government advisors over there just flew over the area in a helicopter and said, "No, there is nothing to worry about, no oil has come up, so we shouldn't be concerned with the situation yet." But I wonder if there is an international organization that can do something about this situation. The tanker is still down there, and it can break loose anytime, and we will have 300,000 barrels of oil contaminating not only the coast of Colombia but who knows where else. Is there any entity that can help these situations?

Parsky: Well, I know of no international organization that is specifically given the responsibility of that kind of rescue mission. However, I would say this, that there does exist a good deal of expertise in our government. We have very good and growing relationships with your country. There are some differences on a number of issues, in some of which I've been very involved; I don't see any reason why, if an effort is made toward our government, we couldn't assist by providing some degree of technical expertise to help you. I know of no international body that would be geared to do that, but I don't see any reason why an effort isn't made by your ambassador in Washington to address directly to our government that kind of problem.

Question: What about it if it happens anywhere else in the world? Shouldn't this experience be profited from in the future, because I'm sure this is not going to be the first situation, and it will not be the last.

Parsky: Well, I must say that if this is a situation that is something that is going to be recurring, there ought to be some vehicle within an existing international organization. I'm very reluctant to advocate the creation of new organizations. We do that a lot, I think, both in our own government and outside, and so I would be very reluctant to try to create a new organization just for that, but within one of the existing entities, if this is a problem that ought to be addressed, I think that we could do that.

Question: I am puzzled by what you said that we can increase supply by policy while from what we saw this morning the reserve is fixed. Thank you.

Parsky: That—what is fixed?

Question: The reserve. I mean what now is already fixed, you cannot increase it by government policy.

Parsky: Well, you may argue that the proven reserves are fixed; in fact some argue that unproved reserves are fixed, but the development of those resources is not fixed. As a matter of fact, there is potential for development that hasn't been properly utilized. The thrust of what I was trying to say is that from our standpoint in the United States, I think that we have failed to recognize what is needed in order to accomplish the objective we set out. By setting out the objective of reducing our vulnerability, if you will, and people may disagree with that as an objective, but that's an objective we set for ourselves. By setting that objective out, then we have to adopt policies that are going to ensure that that happens, and by controlling the price or by allocating the supply, by adopting uneconomic policies, we are not going to develop the necessary supplies. But the amount of production is not at this moment totally capped. That's the only point. You may say that you know exactly how much resources exist, but within that finite amount, there's plenty of room for additional development.

Question: I believe your talk, your speech, even calls for a sort of a workshop in order to really go through several statements made by you, which I consider very interesting. First, you said that you would like to see a minimum of government intervention. Of course I've heard that said many times over. The first question will be "How much is minimum?" Of course every government has its own way of looking at this, but it

seems to me that if you are going to deal with situations inside the United States and outside of the United States, the government will have to have a big hand in controlling what you do, anyway. No matter what you say. I mean you may be saying that just for the sake of making people peaceful and tranquil and you know all that but you have to have a strong hand, see. I remember the saying that a society abandoned to its own internal domestic forces, without control, no real strong control from the government, why, it goes nowhere. And I believe in that. One thing is this. Right now you are negotiating, the United States is going to negotiate with the petroleum countries which, bit by bit, day in day out, begin to control their own industries, so in the end, the controller of these activities outside the United States ought to be the governments of a lot of countries. So if we cannot sit down with private enterprise because of that, and besides the United States will trust private enterprise to take care of that, I believe, but you'll have to do it on a government to government basis, and that's No. 1.

And No. 2, you've already confessed that there is no energy policy in the United States. It's very difficult. You have the federal government, you have the state governments, you have the town governments, you have the municipal governments; then, on top of that you have the oil producers, you have the gas producers, you have the coal producers. Oh! It's a holy mess! So, that's why you cannot have an energy policy. If you don't become strong I don't see how it's going to do it. Now it's your turn.

Parsky: Well, you've made a lot of comments to which I can respond in a number of ways. I didn't mean to say that the government doesn't have a role. The government does have a role. The government's policy, whether it be in the economic area, or the energy area, or in any aspect of our lives, moves or guides our country by establishing policy. We set tax policies which have an effect on the direction in which our economy goes. A tax incentive to private industry will result in capital and resources flowing in that direction. Therefore, I didn't mean to suggest that there is no role for the government. What I said was that the government has extended itself to a point where it is governing every aspect of the way in which our private sector governs its life. I recognize what you're saying is that it's difficult to say that a market can operate when you have governments on one side and industry on the other side. But I didn't mean to suggest that a pure, free market is going to function. The United States right now has a choice of moving itself closer toward complete goverment dominance, and we've seen what economies are like when they are governed totally by governments. You look at the economies of the world. Look at a country like the Soviet Union which controls exactly what is going to happen in their country. And you look to see where they are looking for their agricultural supplies. They have as much farmland as we do, but the production doesn't occur. Because the incentives aren't there, the private sector has not developed.

This country now has clear choices to make. And I'm not saying the government doesn't have a role to play; it does. And I'm not saying the government won't continue to be a part of discussions of government-to-government policies, but I continue to believe that the private sector has the principal role for development in our country, and can play a critical role in the development of the developing countries' economies if those countries will allow the private sector from other countries to participate in the process. If they miss that opportunity at this point in time, I think they are missing an opportunity in which economic growth can take place that they will never be able to regain. That's all I was really trying to say.

Question: Sir, I want to comment on something you said, but before that I want to comment on the remark of the gentleman from Indonesia. In my opinion there is nothing called a "fixed reserve"; it is an always changing picture because by definition it is a function of the technological level, and that's what's going in this country, and enhanced recovery is just changing the amount of residual oil you can take from the ground. And so it is always changing. The other thing you said, and I want to comment about it, you said that the decline in the U.S. production level is a function of the prices. I don't fully agree with that, because in my opinion the decline of the U.S. production to the second place since the turn of the century

is due to the natural decline of the reservoirs themselves. The reservoirs whether under primary or secondary recovery just reach a peak and decline; but probably what you meant if you increase the price, we will raise the economic lineage of existing fields, and this will increase the remaining reserves. The second way the price will push the reserves up is giving us money to go further, for example, in the deeper waters. Now it is estimated that it will cost between 4–5 thousand dollars per barrel per day of production capacity, so you can imagine what would happen when you go to 5,000 or 6,000 feet of oil. That's what I think the increase in reserves will come from.

Parsky: Well, I would only say that I didn't mean to suggest that price was the only factor, but price is a factor. And I didn't mean to say that prices had to go up. I just meant to say that prices had to reflect the market. Right now the market is set by the oil-producing countries. If some alternate supplies were elsewhere and the market was determining that prices would be elsewhere, I wouldn't say that the price had necessarily to go up, I wouldn't say that the price ought to be maintained artificially high. But I don't think that the price ought to be maintained artificially low either in the U.S., because I think it is a deterrent, and I think if you look at the figures on production, you'll see that in fact there has been a decline as uncertainty was created. You're right. There is no question that much of the production has come forth in this country, but there is production that can come forth if the price is there, if the return is there. That's all I was trying to say.

I might just make one other comment to this gentleman because I meant to say this. The role of the government I think is adequately reflected in the number of different energy entities in the U.S. government that in fact have blossomed over the recent past in terms of affecting our energy policy. If you just look at the number of entities in Washington alone: You have the Department of the Interior, and you have the Treasury Department, and you have the State Department, and you have the Federal Energy Administration, and the Energy Research and Development Administration, and the Energy Resources Council, and the Department of Commerce, all of whom have something to say about energy policy. It makes it very difficult for an industry to develop and grow when you have at the federal level alone that many entities. I think the most positive thing that we could do would be to consolidate all of that into one entity. That hasn't happened yet, but I think we should be moving in that direction, and we should be eliminating as many different agencies and as many different involvements by the federal government as we can.

Question: I am from Egypt . . .

Parsky: Did you say from Egypt? Well, when you mentioned Egypt it reminded me of one other thing. We've done a lot of work with your country, and I've been quite heartened by some of the progress that has been made. I recently met with your oil minister, Minister Hilal, here in Washington, and we talked about the need for investment in your country, and the potential for regenerating the economy through oil. It's interesting because I happen to believe that the potential for oil exports from Egypt hasn't been tapped yet, and I think this is going to continue to grow. It will grow slowly, but I think it's going to grow and will have a significant impact on the economy. I just couldn't help mentioning that because I think it's important to the country. I'm very sorry, go ahead.

Question: Oh, that's all right. Sometimes I think you make some of this sound a little bit easy, our peculiarities from the state government here in Austin. There was a catchy little phrase popular here in Texas sometime back, I'll leave out part of it, it said "let them freeze in the dark." Do I take it that you will shortly have off-shore drilling on the East Coast of the U.S.? They have objected to it very strongly in the past. There's oil there. The federal government owns it. Can you have it produced?

Parsky: I must say that I have been a strong advocate of off-shore production on the East Coast, of increasing refinery capacity on the East Coast, consistent with the environmental concerns that have been expressed in the past. I'm sure that you are as aware as anybody of the political process in this country and of the problems that have existed, and unfortunately on the East Coast many people have re-

sponded by saying, yes, we want refinery capacity, yes, we want production, but somewhere else, and that's been a problem. I think we will have refinery capacity there, sooner rather than later, and I think that we will have production too. But the process is not happening as quickly as it should. From my standpoint, I think it's needed.

Question: I do want to compliment you for having covered a very vast realm in a brief speech. But when you addressed yourself to the problems of consumers, I do want to point out that it's fair to divide the consumers into two categories: the developed countries and the developing countries. And when I say developing countries, I mean particularly oil-importing developing countries. I would be most interested in your reaction to how the problems being faced by the oil-importing developing countries could be solved, particularly when you do know that the short-term concessional assistance, which is the standard stock answer to their problems, has only resulted in accumulation of debt abilities, beyond manageable proportions. And that concessional assistance, after all, are loans to be paid by these poor countries with very low per capita incomes. I would be interested in your personal reaction, and would very much value the reply on the basis of official policies of U.S. which you very graciously offered to also explain and underscore. Thank you very much.

Parsky: Well, if there is a difference between my personal observations and my official observations I'm liable to get into a lot of trouble, so I'd better make it just all official. It'll be my personal observations as well. There's been a good deal of publicity, and a good deal of concern expressed about the problems of the non-oil developing countries. There are problems that exist. The problems or the publicity I think has been focused on the *debt* side of the equation, and not enough attention has been paid to the current account balance of payments problems. Those particular problems have been caused, not the debt problems, long-term debt problems, but the current account balance of payments problems have been caused to a significant extent by the increase in the price of oil. If you look at the relationship between those current account problems and the price of oil, I think you will see the heart of a good deal of the immediate problem. I happen to believe, however, that the financing aspect of those balance of payments problems are manageable by most countries if we get increased commitments from the producing countries on an increasing level and if our private capital flows which have come in the past will continue. The U.S. is committed in fact to providing aid and concessional aid if you will. It doesn't help the underlying problems of the economies. The only thing that's going to strengthen the underlying problems of the economies is to provide the necessary ingredients for productive capacity, and when you have countries that are heavily dependent on one or two commodities, there's a need to provide the potential for export. That's the way in which economies are going to grow. The U.S. has got to assert leadership in providing that, not necessarily by rigging prices or fixing prices but providing compensatory finance where it's called for, by providing concessional assistance, and more important by helping countries develop the climate that will attract investment because if there's a potential for return on investment the productive capacity will increase, the ability to stand on their own feet will increase, and the ability to export will increase. But the balance of payments problems of the non-oil developing countries, I believe, are manageable with the proper input, and it's coming. The producing countries are giving much more, that has to increase, not just to the countries in the Arab part of the world, but all over the world. And as that increases, and as we can develop the capacity for productivity, then you're going to see these countries grow. By maintaining a policy of just providing aid, you are not providing the long-term answer to any country whether it be Egypt or any other country.

Question: May I just add one complementary question? You recognize that the problem which has been created by the price hike in oil and price hike in other commodities is much more urgent than the pace in which some of these solutions are proceeding. My fear is that the two exercises are completely out of step with each other, and I don't see how, for example, providing increased success to developed markets is going to come

out—simultaneously to relieve the pressure which is immediate and urgent.

Parsky: You're absolutely right in terms of the immediate need. What we have to do, however, is achieve a balance between providing that immediate need and ensuring that that immediate need is not prolonged. What we need to do is provide the kind of assistance you're talking about to get certain countries, not blanketed since not every country is in the same situation and not every non-oil developing country is in the same situation. But where we see a critical problem, where the immediate relief cannot be found through self-help, the developed countries and producing countries have got to provide that assistance but not in such a way that it's not conditioned. If you will, it must be geared in fact to allowing countries to help themselves, allowing countries to in fact ensure in the future that four years from now, five years from now that kind of help won't be needed. But you're absolutely right—we are not proceeding with respect to some countries at a fast enough pace.

Question: I am delighted this evening to hear this address by the Honorable Parsky, because I did hear him a long time ago. However, I was wondering when he spoke about cooperation between the OPEC and the consumer countries. I would like to hear his observation, not official, but his observation how cooperation in that field could be done now? I am not saying that competition between producer and consumer, but I would like to see or hear his comments on how this cooperation–on what lines he thinks of that cooperation–if I may ask the question.

Parsky: What I tried to emphasize before—although there are differences that exist in terms of how oil is priced, the level, whether it should be increased or not. There are some common objectives that exist between the producers and the consumers, and those common objectives should be drawn on to bring the countries closer together. The producing countries—your country Saudi Arabia is a prime example—want to diversify their economies. It now recognizes that now is the time it can ensure its future. You want to diversify. In order for that to happen you need technical, managerial skills, you need some labor, but you need the kind of experience that many developed countries can provide—and you'll pay for it—and the U.S. and other developed countries should provide that kind of assistance. It's a common bond that can bring us together. In addition you need goods. Those goods can be supplied through exports from the developed countries. The potential for OPEC as a whole is enormous over a period. I think that imports into the oil-producing countries will grow from something like $37 billion in 1976 to $133 billion, the potential $133 billion in 1985—that's a lot of potential exports from the developed countries. It's a common bond—once industries are developed in Saudi Arabia you need a market if your economy is going to be able to grow so that you can export, so that you can generate a growing economy. The developed countries offer markets for those exports at the same time. Now while you're waiting for that development to take place, Saudi Arabia has resources to invest—surplus oil money that can be invested outside. This does exist in Saudi Arabia and will continue. Now I happen to believe that many of the fears that were expressed in this country and many of the politicians said that oil-producing countries with this money were going to take over our industry and were going to disrupt our economy—all of that was more rhetoric than anything. I've talked to all of the leaders in the countries, and I know the policy that's being pursued with respect to the investment. In Saudi Arabia in particular, and with any of the Arab countries, the policy is to make conservative, safe, investments. Saudi Arabia is to some degree more conservative than other countries. They have no desire to control companies. Many of your leaders are having enough problems with their own country, let alone trying to take over a company in the U.S. But the fact that you need markets for that investment and the fact that the U.S. is the largest capital market of any country is another bond. My feeling is that all these bonds should be drawn together—that's the way in which we can create greater understanding—that's the way Saudi Arabia or Venezuela or any country can in fact begin to understand the impact of decisions they make in their country, on oil price, on other prices, the impact that it

has on the developed countries. If we push things aside, and some people have advocated this, some people in our government—in our Congress—around this country—would say no, don't do any of that. You should be cutting off your economic ties. You should be restricting investment as a means of affecting the price of oil. I think that's ridiculous, it's the wrong direction to go in, I think there are bonds—those are the kind of bonds I think need to be built on.

Question: Secretary Parsky–if I understood your comments well, you advocate free market competition for oil prices in the U.S. at the national level. However, if one would follow the same type of argument at the international level, one would see that the oil-producing countries could very well set the prices for the oil. How would you comment on this?

Parsky: Thank you. Well, I thought I had mentioned that there's no question that the oil-producing countries have the ability to control the price. And I happen to believe that they'll continue to have that ability for the rest of this decade. My point however, is that we will not affect that by seeking to adopt confrontational means. The only way in which we are going to affect the ability to set the price and return closer to the market price is by, in fact, developing alternative supplies. And even then it will be dependent on how great the demand is, because if the demand increases in developing countries or others, then it's going to be made more difficult. I was trying to say that in this country we should be moving closer to allowing the market to set the price and internationally we should not be seeking to negotiate a price, but rather we should be seeking to have other countries where their potential for resources brings out these resources. And if the producers want to participate, if investments want to be made in the development of energy in the U.S. or in other countries, I would welcome it, because it is by the development of energy resources that I think we will eventually have the ability to affect the price, not before.

Question: If I may, they may choose to stop the increase in production in their own countries, because they might feel it would be to their interest—what should then be the policy of the U.S.?

Parsky: If the producing countries want to increase production, they are more than welcome to do that. It will affect the price, eventually, if it's increased enough. I don't believe the production in the countries will be increased to such an extent that we will have $2 a barrel oil again, but I certainly am not going to object if the producing countries want to increase production at all.

Question: How about a decrease in production?

Parsky: Well, again, that's what's taken place. In order to maintain the increased price, production has been reduced and the un-utilized capacity in many countries has reached its peak. Saudi Arabia still has the potential to reduce its production by 3 or 4 million barrels of oil a day, if they want, without seriously damaging the amount that's needed, and that's why Saudi Arabia holds such a key to the development or the implementation I should say, of OPEC's policy in the near term. Again, I have indicated on many occasions that I don't believe that increasing the price of oil is justifiable economically, and I feel that it could potentially damage the economies of the world. It could hurt our recovery, it could hurt the European recovery, and it could affect demand. But, again we are in a situation where the oil-producing countries have the unilateral right to do that, and I think the process of cooperation will bring a greater appreciation for the effect that setting various production levels and affecting price will have. And I think that's the only way we are going to affect pricing decisions in the short term. In the long term, as I said, I think we have the potential to have a major impact on the price. I thank you all very much.

Session I

Energy Sources, Technologies, and Utilization Constraints

Overview Presentation

Dr. John J. McKetta
Former Dean of Engineering at The University of Texas at Austin

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Energy Sources: Geographical Distribution and Availability

Dr. William L. Fisher
Assistant U.S. Secretary of the Interior

Energy Technologies: Status and Relative Economics

Dr. Herbert H. Woodson
Director of the Center for Energy Studies at The University of Texas at Austin

Discussion of McKetta, Fisher, and Woodson Presentations

Energy Utilization Constraints: Financial, Environmental, and Political

The Honorable Frank N. Ikard
President, American Petroleum Institute

Discussion

Overview Presentation

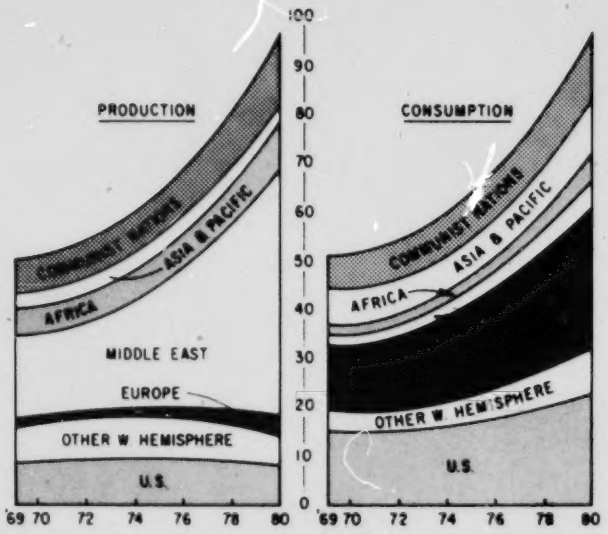
Dr. John J. McKetta
Former Dean of Engineering at The University of Texas at Austin

Many of us in our own respective countries have been very concerned because we realize we are in the midst of an energy crunch. Although we have trouble in individual countries, we've been comforted by feeling there is not an energy crunch in the entire world. But is this true? Will there be an energy crunch in the entire world during our lifetime? There possibly could be! We hear so many facts and so many figures about the vast amounts of energy—inexhaustible supplies of energy—that are available. Is this really true? Are these energies really available? Can you and I count on all the trillions and trillions of tons of coal, for example, that exist in the earth? These are the types of questions that we want to provide some answers for, and we'll go into any degree of depth that you wish.

I'd like to start out with a slide to give you an idea of the consumption of one type of energy, the world oil energy production and consumption, to give you an idea and a feel of what we have.

Figure 1 merely indicates to you the amounts of energy that are produced and consumed worldwide in the form of barrels of oil. On the left side you have the amount of oil that is produced. On the right side is the amount that is consumed. At the present time, in 1976, we are producing and consuming somewhere in the neighborhood of 56 to 58 million barrels of oil a day. Now, what is very interesting—and I just want you to get a feel of this—is that the countries that produce the oil are not necessarily the ones that consume the oil. On the left side you'll see the top area shows the total production of the Communist nations from 1970 through 1980, and on the right you'll see the consumption by the Communist countries between 1970 and 1980. They will essentially produce what they will

FIGURE 1
World Production vs. World Consumption



consume. Then immediately below that is a little blue area that shows the Asian Pacific area where they produce small amounts and they consume a lot more, so this will be an importing area. Europe, which is the third from the bottom of the left side, will produce small quantities, relative to the amount of the vast quantities that Europe will need between 1970 and on into the future. And, of course, the sad one is my country, the U.S., at the bottom; which shows that we're going to be heavily dependent on energies brought into our shores from outside our boundaries. It's very important that you understand that this slide indicates merely the oil portion of energies. For example, in the United States, we use about 17½ million barrels of oil a day. But that represents only 44% of our total energy. So, we are using approximately 40 million barrels of oil equivalent energy per day.

Figure 2 merely shows you the growth in the world oil consumption. Although the U.S. is the largest user, other countries are increasing the usage of energies at a higher rate than is the U.S. In 1974, the world produced 56 million barrels of oil a day, and in 1975 we produced only 53 million barrels a day, or a loss of about 5%. In 1975 the top producer of oil was Russia at 9.8 million barrels a day (incidentally, 1975 was the first year that Russia was first). Second was the United States with 8.3 million barrels a day, and decreasing at the rate of 4½% per year. And third was Saudi Arabia with 7 million barrels of oil per day.

Figure 3 indicates again the oil consumption. This one indicates to you the usage in total energy, and the projected uses in total energy in three major areas: On the left is the U.S.A., the center is Western Europe, on the right hand side is Japan's total usage and demand. You can see from this chart that the total demand in both Western Europe and in Japan is increasing at a

FIGURE 2
Growth in World Oil Consumption

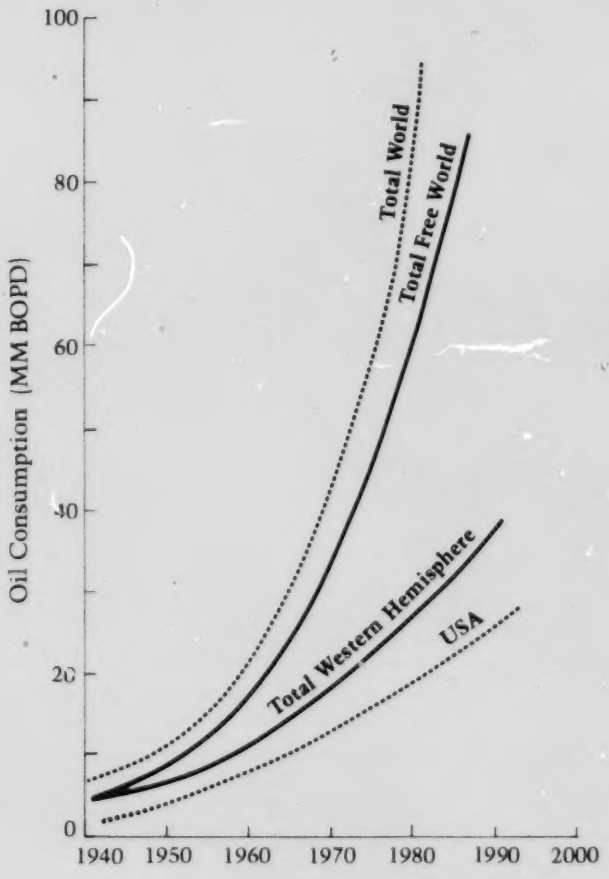


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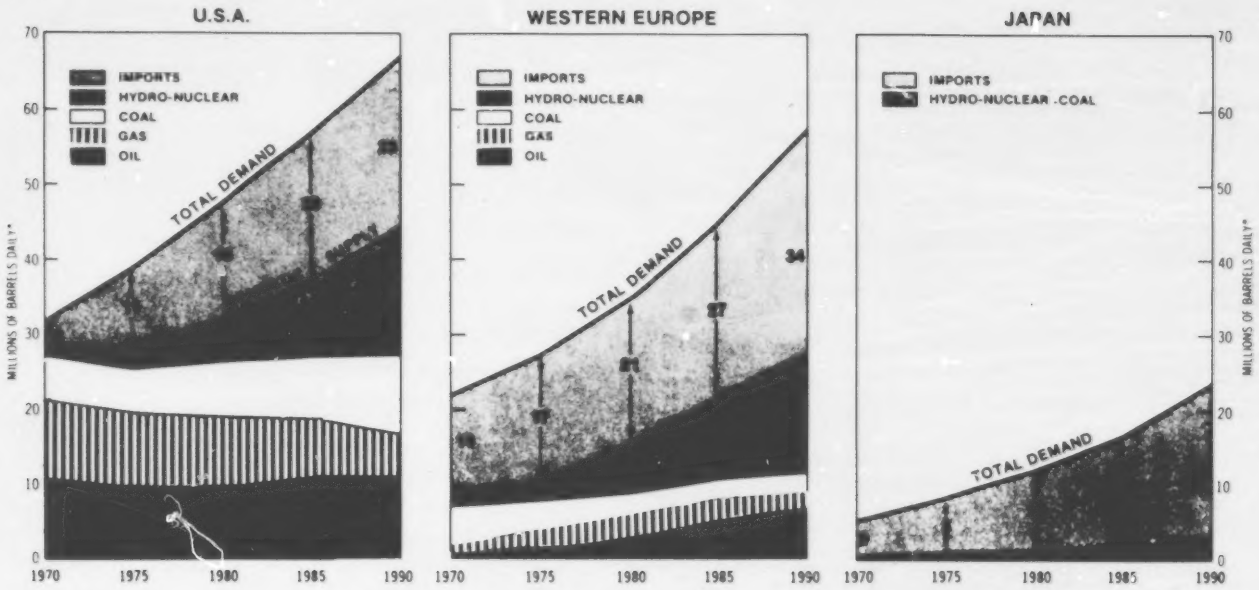
FIGURE 3
Energy Demand vs. Domestic Supply



higher percentage rate than in the United States. The yellow area is the total dependence of these three areas on imported energies. This chart covers three different kinds of areas. On the left hand side you have the U.S. which has a great source of energy. On the right hand side, you have Japan which has almost no domestic reserve of energy. Figure 4 shows—the world of oil on the bottom chart—how the world would look if we would draw the countries in proportion to the total oil reserves. The top map shows how the non-Communist countries would look in the case of the coal reserves. You see where the oil and coal lie. Now on this particular chart I do not show the U.S.S.R. and Siberia coal reserves.

The coal portion of the picture gives you an idea of the vast amount of coal we have in the world—about 10 trillion tons of *total* coal resource. But in the entire world we may have only about 600 billion tons of *recoverable* coal reserves. Thank goodness, that's still a very, very large figure, and it seems we have no worry. But if we look at the total picture, of the ten trillion tons of total coal, the U.S.S.R. has approximately half of that amount, and the United States has a little more than a quarter of that total. These sound like large numbers, but in the United States' case, where we have 2.9 trillion tons of total coal, we have only 200 billion tons that are economically recoverable in the foreseeable future. Even 200 billion tons, at the rate that we are using coal here in the United States, is a 300-year supply. Many of us will not live 300 years, so we don't worry. But, we are basing that figure on the amount of coal we are using today. But if the coal would supply 80% of the total energy in the United States, we would have less than 50 years supply in our coal resources. This does give us reason to worry.

Figure 5 shows you the total discovered oil and the vast amounts of oil reserves. The blue portion on the bottom indicates the reserves.

On March 29th in a U.S. newspaper called *The Wall Street Journal*, I read a statement made by someone who was supposed to be familiar with the energy field. The statement is as follows: "If the non-OPEC countries could find only a single North Sea field or a single North Slope field each five years, then this would put a

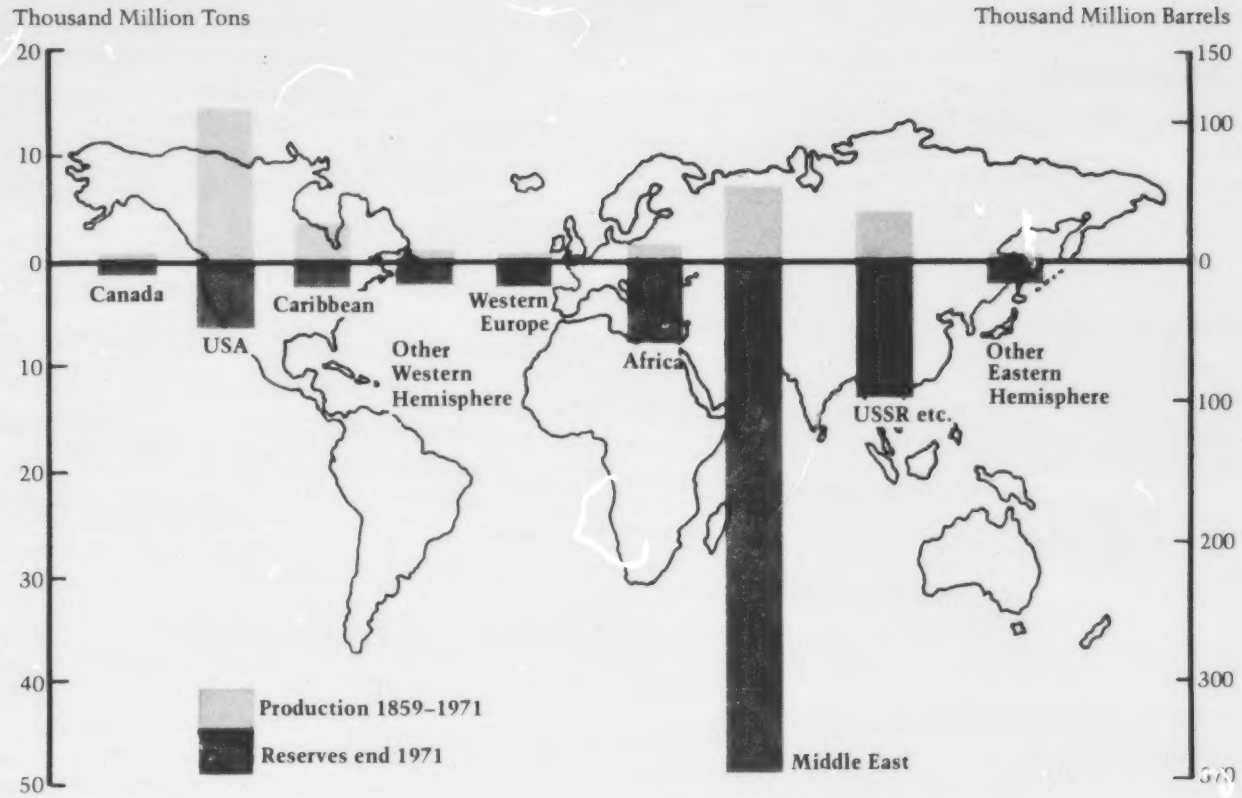
FIGURE 4

The World of Coal

The World of Oil

very serious strain on the OPEC price controls." Now we all admit that the North Slope field is a huge, huge field—possibly 10 billion barrels. We are also very happy to learn that the North Sea field is huge, 8 billion, 10 billion, 12 billion, let's say 15 billion barrels—total—we're really not sure yet. *The Wall Street Journal* quote ignores three key facts. First of all, these fields were not found in one year. We drilled 640 wells in the North Sea over a 13-year period in order to find this field that we feel may be 15 billion barrels of reserves. Second, it takes 8 to 10 years of development to reach full production in the harsh environmental areas where most of the new oil is now being sought. Third, the non-Communist, non-OPEC countries are using oil at the rate of 17 billion barrels a year. So even if you did find a 15-billion barrel field each year, you would be losing at a rate of 2 billion barrels in the world each year! So one North Sea and one North Slope size of field each five years is just not enough. In fact, one of these each year is not enough. For decades we have been finding oil worldwide at a lower rate than we've been producing. In the United States we are finding new oil at about one-half of the rate that we are producing, even though drilling has increased greatly worldwide over the past decade and very rapidly over the past three years in the United States. So to stay even in world energy, we must find new energies, and these new energies must be equivalent to or greater in amount than all of the total energies that we use. Incidentally, a 20 billion barrel oilfield will produce only about 1½ billion barrels per year at the optimum production rate. Plus the fact, you remember the original story was that we somehow would want to put a strain on OPEC's price control, that I would add now that if a country would find a 100 billion barrel oil field, would they sell oil at less than the OPEC price? I only know of one country that would be foolish enough to do so. So what do we do? What do we do? What do we do? We come to a meeting like this where we have some experts such as Dr. Fisher and Dr. Woodson who are going to give us solutions to all these problems that I tried to tell you are insurmountable. Isn't it nice to have them along? Dr. Fisher is going to talk to us on energy sources, the distribution and availability, and then Dr. Woodson is going to tell us how to get these fuels out of the ground or out of the sky or wherever they come from, from the winds, oceans, and so forth.

FIGURE 5
Total Discovered Oil



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Energy Sources: Geographical Distribution and Availability

Dr. William L. Fisher
Assistant U.S. Secretary of the Interior

Let me begin with the customary references to terminology. For the record, the term "reserves" as I shall use it here, means those quantities of an energy resource that have been identified and are considered on the basis of engineering and geological knowledge to be recoverable under current economic conditions with existing technology. The term "resources" includes reserves, but also encompasses deposits already identified but not presently economically recoverable, as well as undiscovered deposits that may or may not be economically producible when found. Resources are transformed into reserves by discovery, or by improvements in technology or economic conditions that make submarginal deposits worth producing. But there can also be retrograde movements whereby reserves move back into the submarginal resources category because of political or economic developments which make it unprofitable to recover them. It's a two-way street.

My second offering is a little homily on numbers. During the course of my presentation I shall be using a lot of numbers, from different sources, derived by different methods, based on different assumptions, made at different times, and sometimes even describing different things in the same series. They do, however, have one indispensable quality: They are available. Taken very loosely, they suggest something of the magnitude of the energy resources we know about, or infer to exist within and on the earth, and this is about all we should reasonably expect from descriptions of things that are inherently incommensurable. So a caveat: Don't take the numbers I give you too literally, but simply accept them for what they are: a collage of contemporary guesswork about the world's mineral fuel endowment.

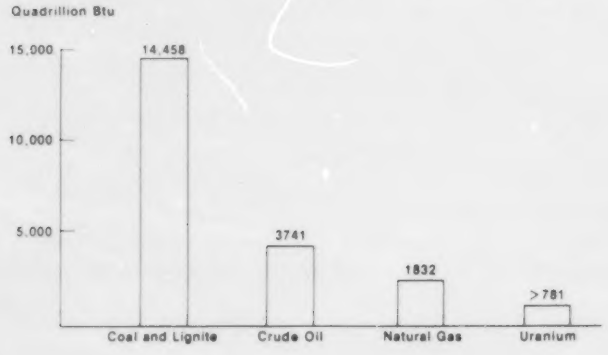
The reserve figures range from fair to good in quality, because something is known of the geometry and quality of the deposits which comprise them. But the resources estimates, which have the impossible task of measuring the unmeasurable, range in quality from fair down to some indeterminate point between terrible and awful. They are useful chiefly to convey some general notion as to the relative abundance of the respective energy resources and to indicate target figures for exploration if technological, political, and economic developments permit.

World Energy Reserves

First, let's take a quick overview of the world's nonrenewable energy reserves—the banked resources that are available to us now. Figure 1 shows the relative size of estimated known worldwide reserves of coal, crude oil, natural gas, and uranium, expressed in British Thermal Units. It should be no surprise to you that coal is by far the most abundant resource, notwithstanding its small share of world energy markets. Oil and gas reserves taken together total less than 40 percent of the energy available from coal, although they supply two-thirds of all energy demands, and are due to continue this dominant position for at least the next two decades.

The estimates for uranium need some explanation. We have no data for the Communist countries, so the world total is something more than the number shown. The estimates include only the tonnage of uranium oxide that was believed to be minable at $15 a pound or less in 1973. In 1976 it is hard to keep from laughing out loud when anyone mentions uranium at $15 a pound—unless you work for Westinghouse, where nobody laughs about such things—so you are free to assign your own discount factor to the total shown on the chart. The heat value assigned to uranium assumes a conversion rate of 400 billion Btu per ton of uranium as used in the present generation of nonbreeder reactors. Obviously, the advent of a successful breeder reactor would radically increase the size of the uranium column on the chart.

FIGURE 1
Measured World Nonrenewable Energy Reserves, 1973



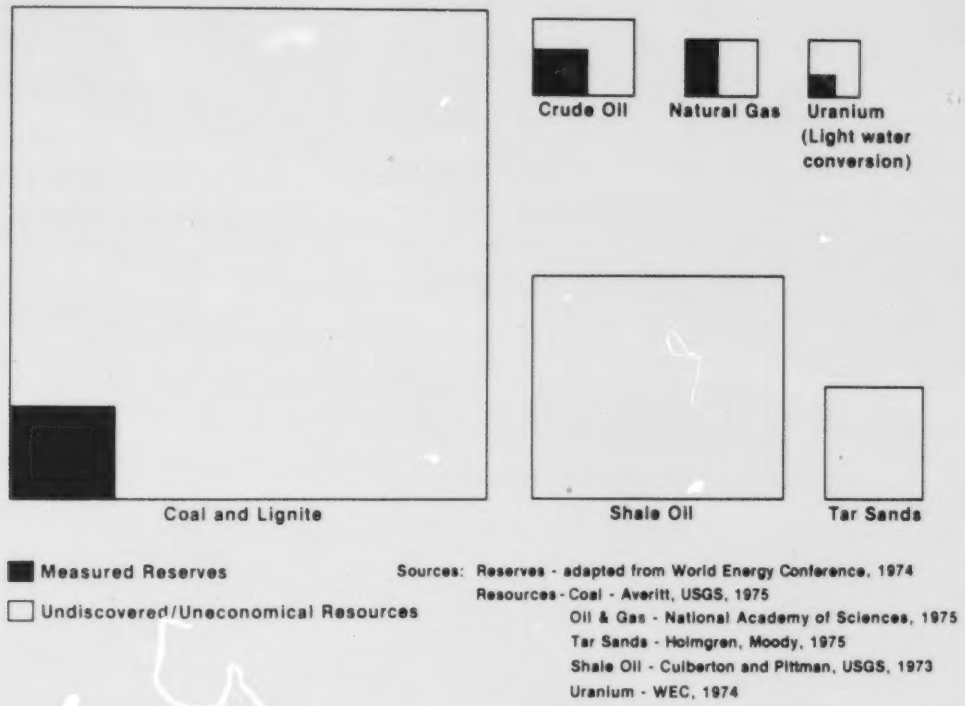
Source: Survey of Energy Resources, World Energy Conference, 1974

I have not included tar sands and oil shale in the presentation of reserves, because they do not fit my definition of reserves as commercially producible resources. It is true that the Great Canadian Oil Sands Company is, after a long string of deficits, now profitably producing some 55,000 barrels of oil a day from the Athabaska sands of Northern Alberta, and Estonia and Manchuria each have a modest shale oil industry. But there is no great rush of other companies into the tar sands business at current estimates of two to three billion dollars for plants of 100,000 barrels a day capacity, and Atlantic Richfield's ride on the construction cost escalator with its Colony Development shale oil venture is well known. For these reasons, I don't think it is possible at this time to produce any figures on oil shale or tar sands that are in any way comparable to demonstrated reserves of oil, gas, or coal. The same holds true for thorium, which is presently in limbo as a commercial possibility because of reactor costs, even though demonstrated to be a technical success at the Philadelphia Electric's Peach Bottom Plant No. 1.

World Energy Resources

Total energy resources, as you might suppose, are estimated to be much greater than the portion that has been identified as reserves, for they not only include extrapolations of sources currently being used, but also the estimates of additional sources such as oil shale and tar sands, which contain immense amounts of energy. Figure 2 shows a summary comparison of estimated energy reserves and undiscovered or uneconomic resources. The numbers are so large and so ill-founded as to be meaningless, so I have just used size

FIGURE 2
World Nonrenewable Energy Resources Reserves and Undiscovered/Uneconomical Resources Circa 1974


Crude Oil
Natural Gas
Uranium (Light water conversion)
Coal and Lignite
Shale Oil
Tar Sands
Measured Reserves
Undiscovered/Uneconomical Resources
Sources: Reserves - adapted from World Energy Conference, 1974
Resources - Coal - Averitt, USGS, 1975
Oil & Gas - National Academy of Sciences, 1975
Tar Sands - Holmgren, Moody, 1975
Shale Oil - Culberton and Pittman, USGS, 1973
Uranium - WEC, 1974

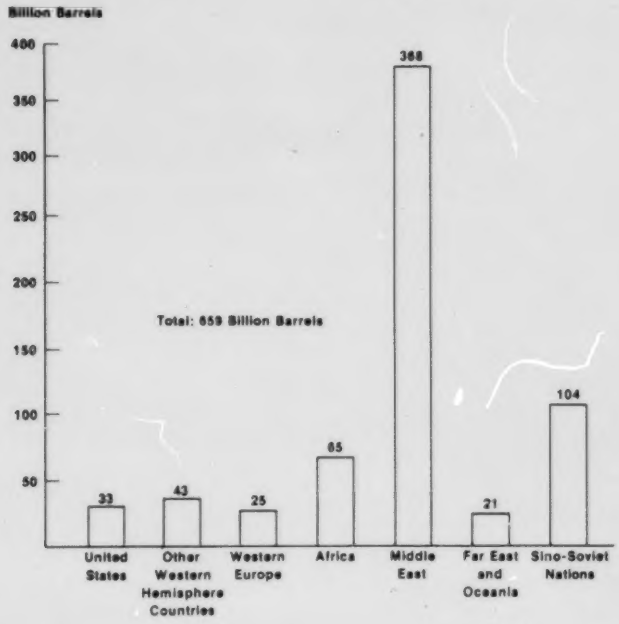
blocks in the chart to suggest the relative abundance of the various sources on a common basis, specifically, their Btu content. The white areas shown are the portions of the respective resources that are in the reserve category. As you can see, huge as the world's known coal reserves are, they comprise but a small fraction of estimated total coal resources—about five percent, actually. Next in size order of total resources come shale oil and tar sands, to which I have not assigned any reserves, hence the lack of any white areas in these blocks. The three least abundant resources, at the current state of technology, are crude oil, natural gas, and uranium, in that order. But, remember, of course, that we are evaluating uranium as it is used in present-day burner reactors. In a breeder reactor format the uranium square would be at least as big as the one devoted to coal, maybe bigger, depending on the conversion rate obtained. I have ignored thorium on this chart, because we have no estimates for undiscovered resources that would permit a meaningful comparison of thorium with the other mineral fuels. Identified resources of thorium, converted to Btu values on the basis of the Peach Bottom gas reactor experience, would make a square about half the size of the one shown for uranium. But we have every reason to believe that very large amounts of thorium could be found if it became worthwhile to look for them.

Oil

Let me now turn to a more detailed discussion of each of the principal sources of energy, beginning with petroleum.

Figure 3 substantiates the general understanding about the distribution of known petroleum reserves in

FIGURE 3
World Crude Oil Reserves by Region, January 1, 1976



Source: Oil and Gas Journal, 1976

the world: Overwhelmingly, they occur in the Middle East, which has well over half the total and about three and one-half times the reserves of the next largest aggregate, which is the Communist block. Middle East reserves are about 11 times those of the United States. Within the Middle East Region, petroleum reserves are heavily concentrated in and around the Persian Gulf. More than half the known reserves of the world are located within 200 miles of the Gulf, and three countries —Saudi Arabia, Kuwait, and Iran—account for 43 percent of the total. More than 220 billion barrels, or a third of total world reserves, are located in 10 large fields in and around the Persian Gulf.

The figures I have just given are for identified reserves. We have allowed ourselves a fudge factor in counting reserves, however, so that the amount of oil we feel reasonably assured of producing some day is actually somewhat more than the totals I have shown. Oil fields—even very old ones—are known to "grow" with the passage of time as field limits are extended, new pools are found within the field, and recovery of original oil in place is improved by advancing technology. These are variously referred to as "indicated additional," "probable," or "inferred" reserves to give them a place between the well established "identified reserves" category and the undiscovered resources, which are estimates by hypothesis and speculation. Figure 4 shows the contributions that these additional reserves are estimated to make to the oil supply of the United States. They constitute an important, near-term source of additional oil.

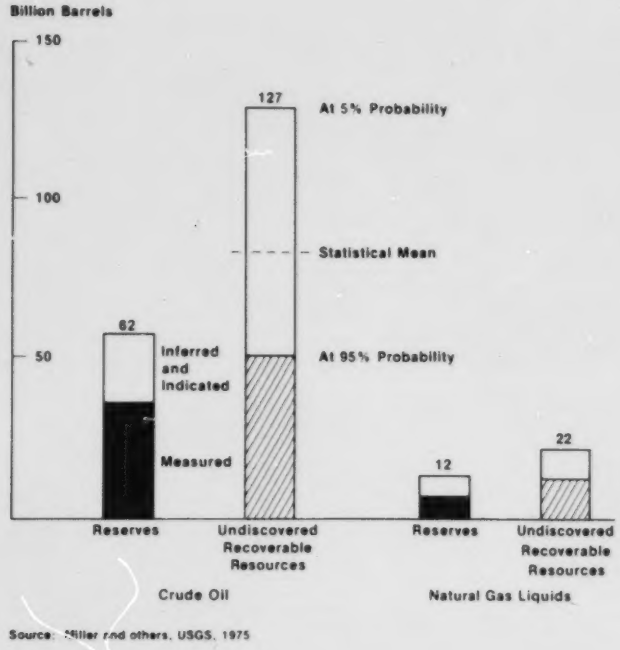
The total of 62 billion barrels for proved plus indicated and inferred reserves is about 17 times 1974 domestic crude oil production and 10 times consumption. Neither figure has the remotest connection with the number of years these reserves would support us at present production and consumption rates, but a comparison of reserves to production and consumption does have some use in determining the intermediate-term outlook for petroleum supply from our own resources.

I have also included estimates of natural gas liquids on this chart because they are treated as liquid petroleum in the United States supply/demand calculations. In fact, however, they are of course the entrained liquids in the natural gas stream, and the values shown on the chart are derivatives of estimates made of natural gas reserves, which we will come to a bit later.

Worldwide, additional reserves in known fields have recently been estimated to be on the order of 195 billion barrels, which when added to identified reserves of 659 billion barrels gives a total for economically recoverable reserves of 854 billion barrels. This figure compares with 1975 production of 20 billion barrels and an all-time cumulative production of 340 billion barrels.

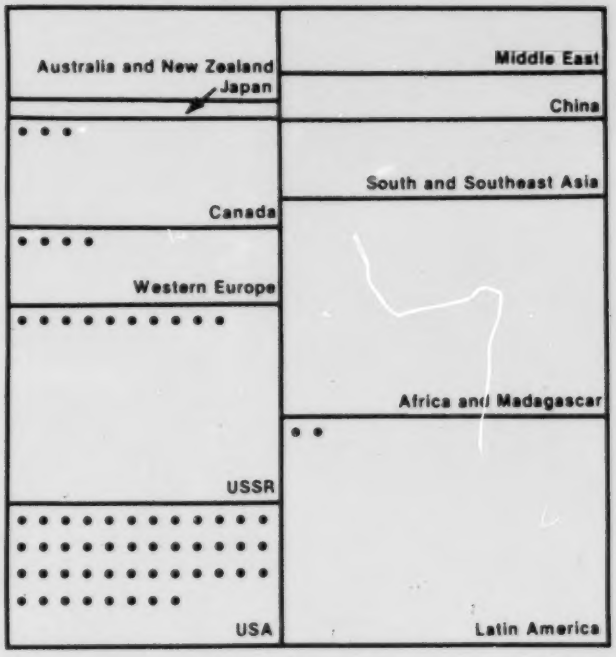
We know, however, that there will be additional discoveries which will result in the accession of heretofore undiscovered resources to the category of economic reserves. In the case of the United States, a team of scientists from the Geological Survey has estimated that these undiscovered recoverable resources will range between 50 and 127 billion barrels of crude oil, as shown on Figure 4. The lower figure is given with a 95 percent degree of confidence, and the upper one at 5 percent confidence. The statistical mean value of the range is 82 billion barrels. Undiscovered natural gas liquids resources add from 11 to 22 billion barrels to

FIGURE 4
Petroleum Resources of the United States, January 1, 1975



Source: Miller and others, USGS, 1975

FIGURE 5
Wells Drilled Compared to Area of Potentially Productive Rock, by Region through 1975



each dot represents 50,000 wells drilled source: Grossling, USGS, 1976

our prospective liquid petroleum supply. Worldwide estimates of petroleum resources vary because of the shortcomings I noted at the outset of my remarks, but a figure of one trillion barrels of recoverable crude oil remaining to be discovered is about as good as any. If this figure has any validity it means that we have found a bit more than half the oil we can expect to discover—probably the easy half.

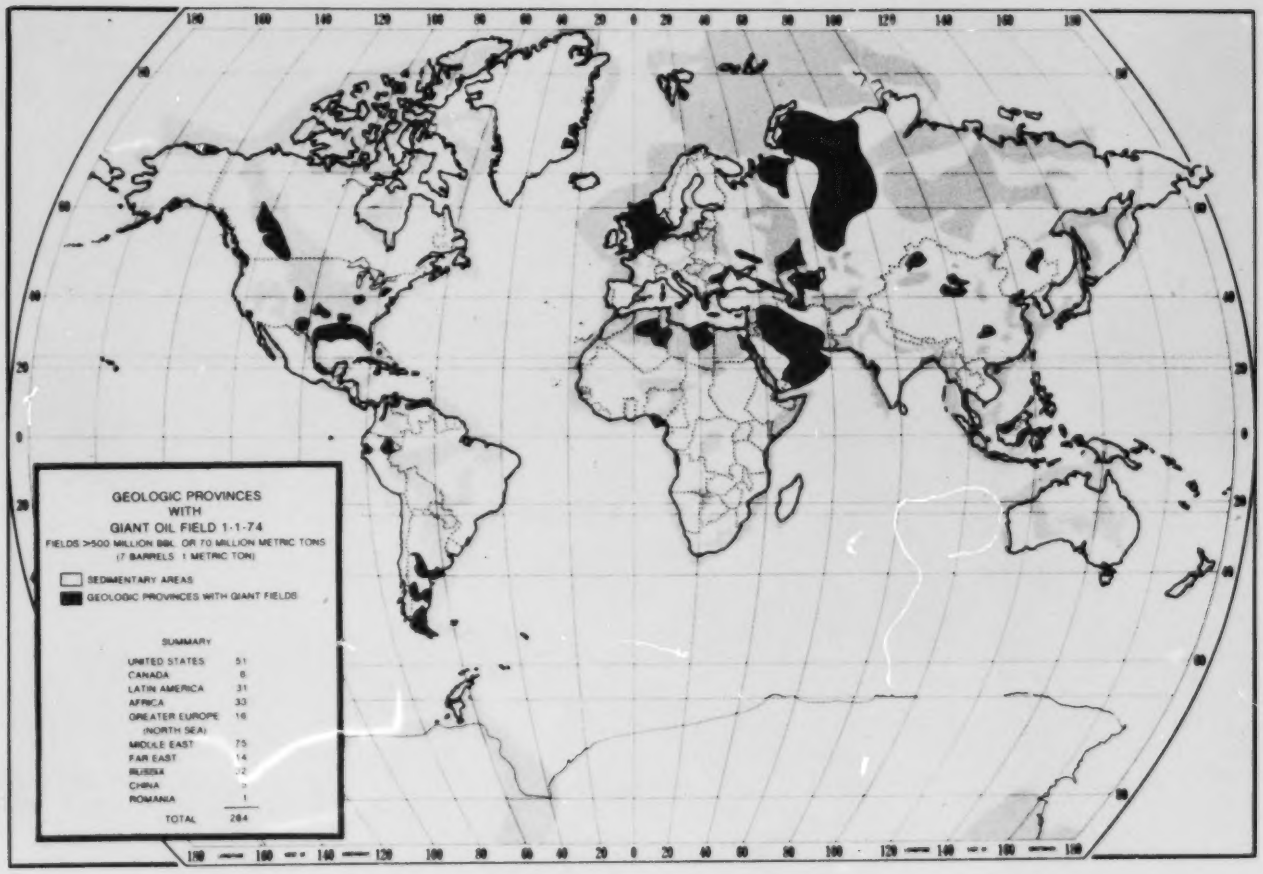
One of the features which makes it so difficult to assess the world's petroleum potential is the widely differing emphasis that has been placed on exploration from one region to the other. Dr. Bernardo Grossling of the Geological Survey has recently completed a study of oil well drilling done in the various regions and countries compared with the areas of what he considers to be sedimentary basins. Just how prospective certain of the basins in Latin America and Africa are is a matter of judgement on which explorationists may disagree. But the slide shows the marked contrasts in relative density of drilling.

The area shown on Figure 5 for each country or region corresponds to the actual area occupied by sedimentary basins in that country or region, with the developed nations shown on the left side and the developing regions on the right. The obvious conclusion to be drawn is that drilling has been overwhelmingly concentrated in the developed areas of the world, particularly the United States, where approximately two-thirds of all drilling has taken place.

The two great blank regions are Latin America, where not more than 100,000 wells have been drilled, and Africa, where only about 15,000 wells have been drilled. This means that, on average, only about one well for every 50 square miles has been drilled in Latin America, and only one well for every 335 square miles in Africa, in contrast to almost one well for every square mile in the United States.

There are many reasons for these discrepancies. Historically, we have drilled for oil in prospective basins

FIGURE 6
Geologic Provinces with Giant Oil Field



closest to markets. We need to be careful about inferring too much from this disparity between drilling effort and prospective territory—we're not likely to solve the world's petroleum supply problems for the next five hundred years by going out and drilling up the rest of the world to the same density as has been done in the United States. At the same time, it suggests that we ought to be careful about downgrading the outlook for further large petroleum discoveries in the world. There are many good places left to look in the relatively untested regions—particularly Africa and Latin America.

Figure 6 presents another view of the world's petroleum potential. It depicts the location of the major sedimentary areas alluded to in Figure 5, together with significant producing provinces and the distribution of the 287 largest oil fields in the world. These giant fields, each originally containing 500 million barrels or more of recoverable oil, account for three-fourths of all past production and reserves. They are found throughout the world, but not surprisingly, most abundantly in the major producing areas, specifically, the Middle East, the United States, northern Africa, South America, the Soviet Union, and the rapidly developing North Sea. Most of them are found in the younger rocks and at depths of less than 10,000 feet. More than

60 of them are located on the continental shelves, a third of these being in the Persian Gulf.

Note that extensive sedimentary areas have not developed significant production. By and large, most of these areas onshore have undergone some testing, as well as most of the shallow areas offshore. But as I have already intimated, exploration in most areas has been limited. We can expect further exploration of these areas as the search for oil and gas progresses, with significant discoveries resulting from the intensified search, especially in the less accessible regions.

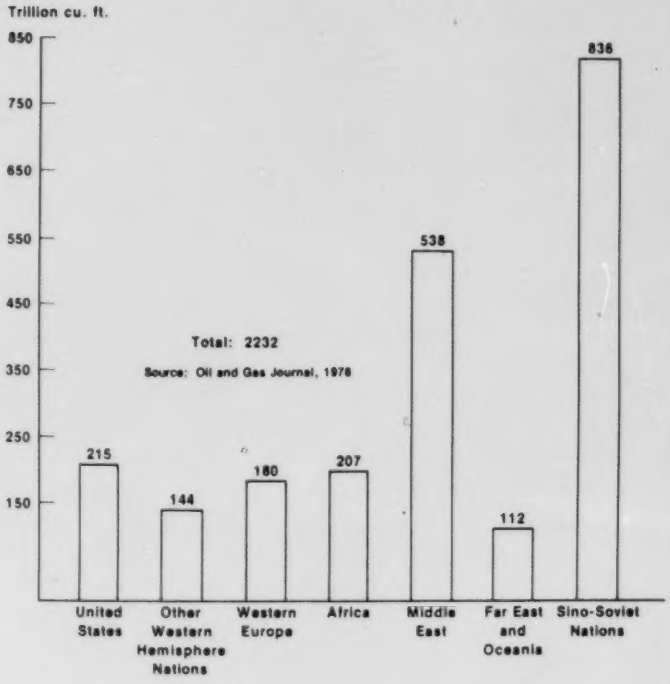
But the deeper stretches of the continental margins—beyond the edge of the shelves—remain virtually untouched, and they may remain so for some time. Technological progress has been uneven in the effort to extend our dominion over the offshore environment. Within the present state of the art, geological structures which might contain oil and gas can be detected by instruments in very deep water. Exploratory wells have been drilled in water depths exceeding 2,000 feet, but being able to produce at such depths is something else. At great cost and risk, the industry is building platforms designed to produce in water depths of about 1,000 feet, but the deepest production so far attained is in depths of less than half that figure. Progress is being made on developing sea-floor production facilities, but many problems remain, and their solution is required before exploitation of the continental slope and rise can be a realistic prospect.

A final word about future petroleum resources. The estimates I have cited all refer to oil presently recoverable, which is about a third of the oil originally in place. With improved technology and higher prices, some part of the two-thirds of the oil which presently remains in the ground would be recoverable, and this surely represents a large target for future development. If we could increase the recovery of crude oil in the United States from the present 32 percent to 40 percent, we could more than double our proved reserves without having to discover a single new field.

Natural Gas

Many of the things I have just said about oil apply to natural gas, which is found in the same geological environments by the same methods and by the same people. There is an important difference, however, in that while some gas is always found in association with oil,

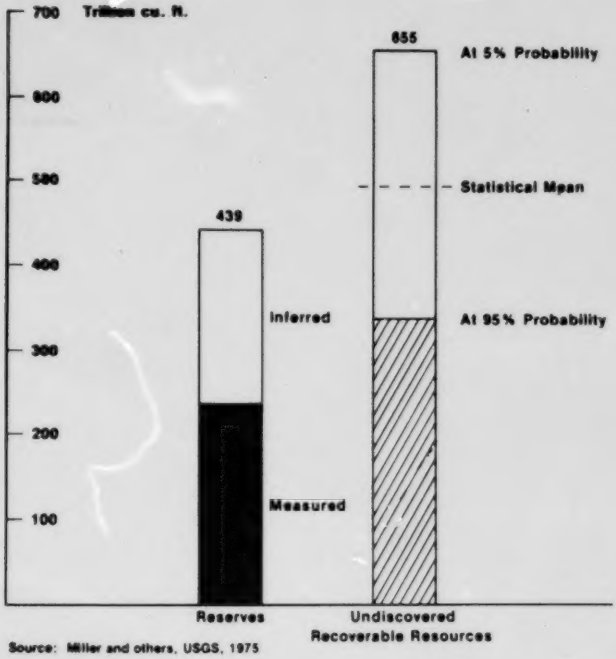
FIGURE 7
World Natural Gas Reserves by Region, January 1, 1976



there are immense deposits of natural gas where no crude oil is present at all. This leads to significant differences in the way in which oil and gas are distributed throughout the world. Whereas the Communist nations have less than a third as much crude oil as the Middle East, the reserves of natural gas are thought to be half again as large, as shown in Figure 7. This anomaly is due to the very large gas fields that have been found within the past two decades in the Soviet Union, and even though the Soviet gas reserves are reported under less stringent definitions than those of the non-Communist nations, they are still very large—very nearly as large as the combined total of all other reserves outside the Middle East.

Marketed natural gas production in 1975 was 48 trillion cubic feet worldwide, or about two percent of proved reserves—almost the same reserve-to-production ratio as exists for oil. Indicated and inferred reserves will add something to this total, but no one to my

FIGURE 8
Natural Gas Resources of the United States, January 1, 1975



Source: Miller and others, USGS, 1975

knowledge has done me the kindness to make a guess as to how much.

These extrapolations are available in the case of United States' natural gas reserves, however, courtesy of the Geological Survey's Resource Appraisal Group which developed the estimates for extended reserves and undiscovered oil resources I presented a few moments ago. Figure 8 shows proved, or measured, reserves of natural gas of 237 trillion cubic feet plus inferred reserves which may be found in existing fields of very nearly as much, for a total reserve figure of 439 trillion cubic feet. Undiscovered recoverable resources are estimated to range between 322 and 655 trillion cubic feet, at 95 and 5 percent confidence levels, with a mean value of 484 trillion cubic feet. All this compares with consumption last year of 20 trillion cubic feet. The estimates for natural gas liquids I discussed earlier were derived from these values using a factor of 33 barrels of NGL per million cubic feet of gas.

Coal

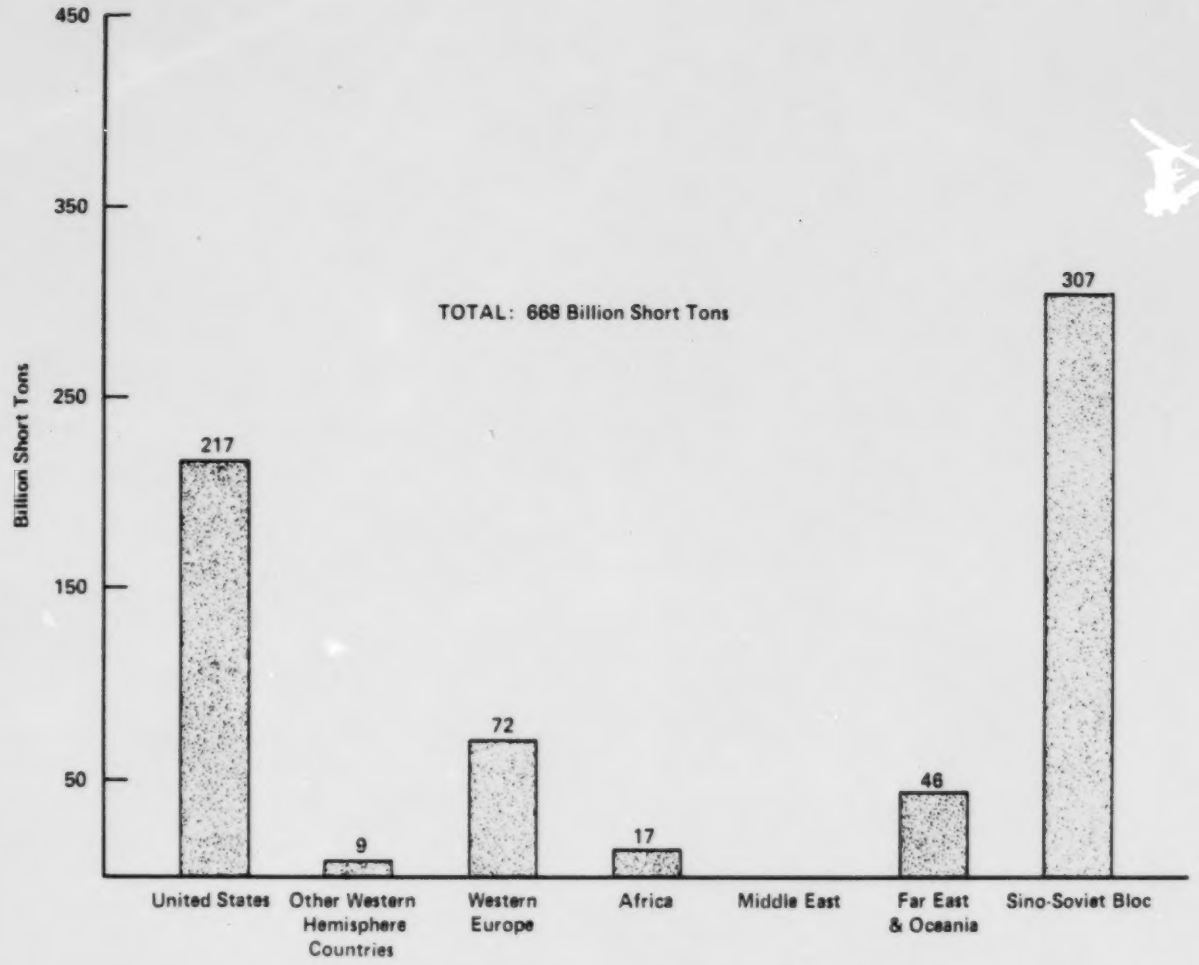
Figure 9 depicts world coal reserves corresponding to proved reserves of oil and gas for the seven major regions of the world. You can see that the distribution of coal reserves is also very uneven, with nearly 80 percent being held by the United States and the Communist nations, particularly the Soviet Union and the People's Republic of China. Obviously, the world reserves of coal are enormous; more than 250 times the 2.5 billion tons produced in 1973.

United States' coal resources are worth a closer look. There are estimated to be 1.7 trillion tons of coal of all ranks in seams 14" or more in thickness that have been identified to 3,000 feet in depth, and another 2.2 trillion tons that are postulated to exist in unmapped and unexplored areas down to 6,000 feet. These are gross figures and mean very little except that we've got a lot of coal, most of which we'll probably never get around to using.

A more meaningful figure for coal is the demonstrated coal reserve base, which includes identified deposits 28 inches or more in thickness for anthracite and bituminous and 60 inches or more for subbituminous and lignite to a maximum depth of 1,000 feet for underground mining and 200 feet for strip mining. The demonstrated reserve base is shown on Figure 10, broken down by general location and sulfur content. It totals 437 billion tons, it says on the chart. Divide that in half to obtain 218 billion tons, which is what we really think we can extract at this time, because coal, like oil, has a limiting recovery factor.

All kinds of things limit recovery of coal. While individual mines often do better than the 50 percent national average—55 to 60 percent for conventional underground room-and-pillar mining and 85 to 90 percent for surface operations—there is a lot of coal in the reserve base that is inopportunely placed. It's under cities or railroads or rivers or lakes or parks or some other surface feature that would suffer from subsidence. If it's strippable there may be a conflict over the use of the surface estate, or problems with property lines and high wall regulations, or environmental considerations may be overriding. Safe and efficient extraction of a coal bed may be prevented by previous mining of an overlying or underlying bed. And in the West there is a lot of coal that is simply too thick to mine by any underground method known to us at present. Present

FIGURE 9
World Recoverable Coal Reserves, 1973



Source: Survey of Energy Resources, World Energy Conference, 1974; U.S. Bureau of Mines, 1974.

FIGURE 10
Demonstrated Coal Reserve Base of the United States, January 1, 1975

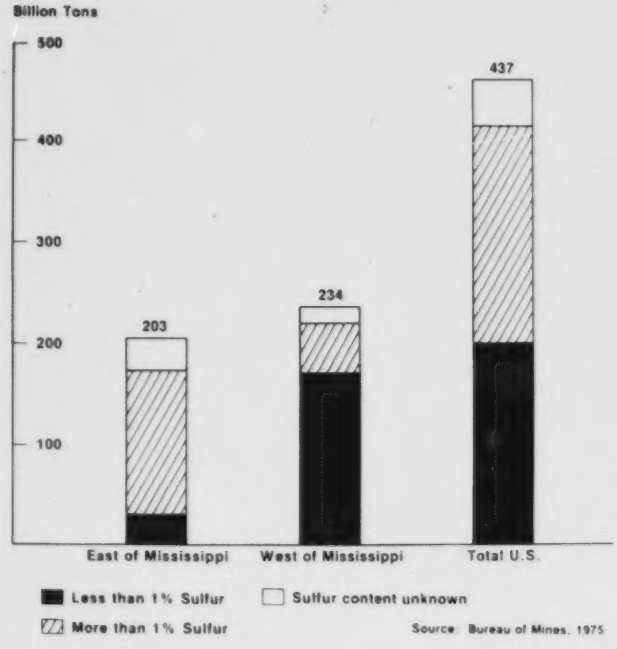
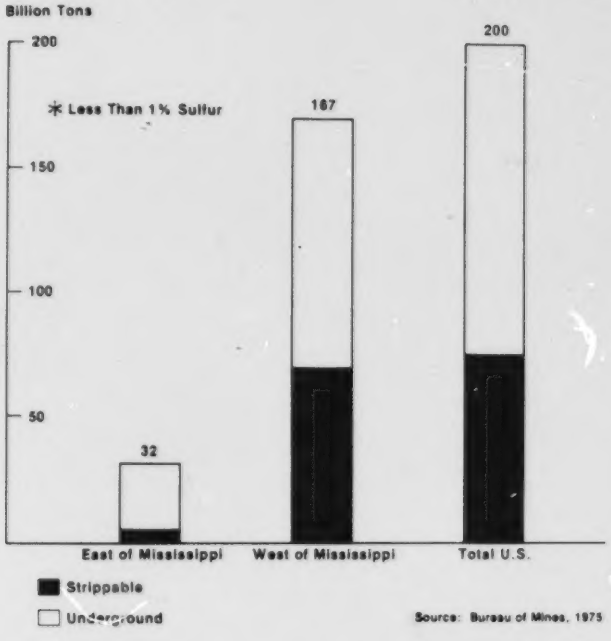


FIGURE 11
Low Sulfur Coal Reserve Base of the United States, January 1, 1975



mining technology is limited to face heights of about 10 feet, but in Wyoming there are deep beds a hundred feet thick, and we're lucky if we can mine as much as five percent of the coal in place.

For these and other reasons, the 437 billion tons of the reserve base are reduced to about 218 billion tons of recoverable coal, most of which is outlawed by the Clean Air Act, but it's there in case we ever get to the point where we have to choose between sneezing and freezing. It's about 400 times what our consumption was last year, and we can expect the recoverable fraction of the reserve base to increase as more efficient extraction methods are developed.

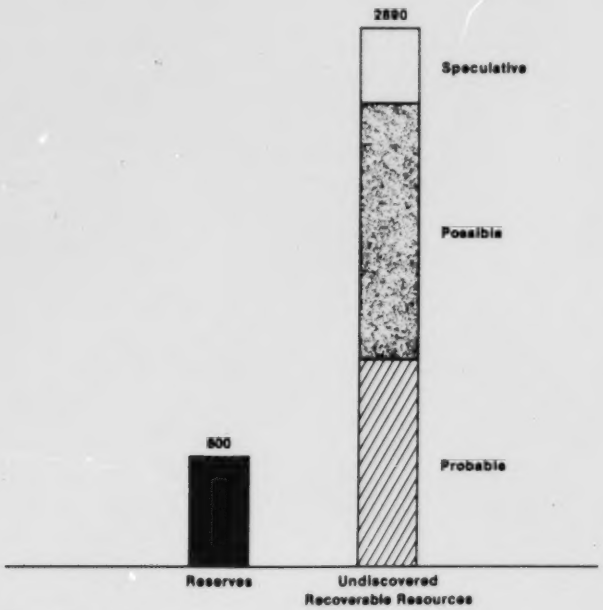
The low-sulfur coal deposits are of interest because of the restrictions on emissions of new plants and ambient air quality standards applied to all plants. Figure 11 shows coal with less than one percent sulfur content analyzed by location and mining method. It says that the overwhelming portion of low-sulfur coal lies west of the Mississippi—about 800 to 1,000 miles west of it, in fact. What it does not say is that most of the relatively small amount of low-sulfur coal east of the Mississippi is of metallurgical grade, too high in value to burn under steam boilers.

It also says that while the amount of strippable low-sulfur coal in western deposits is very large, there is nearly half again as much that can only be reached by underground mining, which suffers from the limitations on seam thickness I noted earlier. Again, remember to divide everything in half to account for the 50 percent recovery factor.

Uranium

Data on uranium resources, reported by the Energy Research and Development Administration as of January 1, 1975, credit the United States with 600,000 tons of uranium oxide reserves available at $30 a pound or less. Undiscovered recoverable resources are esti-

FIGURE 12
United States Uranium Resources (1000 Short Tons U_3O_8 Available at $30/lb. or less)



Source: ERDA, 1975

mated to be about 2,900,000 tons at that price, as shown on Figure 12. These figures don't mean much apart from such imponderables as the outcome of the current nuclear power plant controversy and the time period when the breeder reactor begins to enter the picture in significant numbers. Domestic uranium resources known to be available, plus those projected with a high degree of certainty, are sufficient to provide fuel for all reactors that are expected to be on line by 1990 over their entire lifetime. With the breeder reactor on the scene, supply ceases to be a problem that any of us needs to worry about, and we can instead direct our concerns to the problems of security and waste fuel disposal.

Oil Shale

As in the case of coal, oil shale resources are huge. The Green River Deposits of Colorado, Utah, and Wyoming are estimated to contain 418 billion barrels of oil in place in rock averaging 30 or more gallons per ton and at least 100 feet thick. An additional 1,400 billion barrels is estimated to exist in rock yielding between 10 and 25 gallons per ton.

The prize is therefore a large one. But from the first shale oil "boom" in the early 1920's to the present day, despite a number of attempts, no commercially successful shale oil venture has yet appeared. Except for speculators, oil shale has made conversation, not money, and its chief market thus far has been in paper weights and table tops.

This somber outlook could be changed, of course, by a break-through in extraction technology, such as a successful method for *in-situ* fracturing and retorting, which would eliminate certain of the mining and disposal problems. What shall I say? That there is a chance the problems may be solved Occidentally?

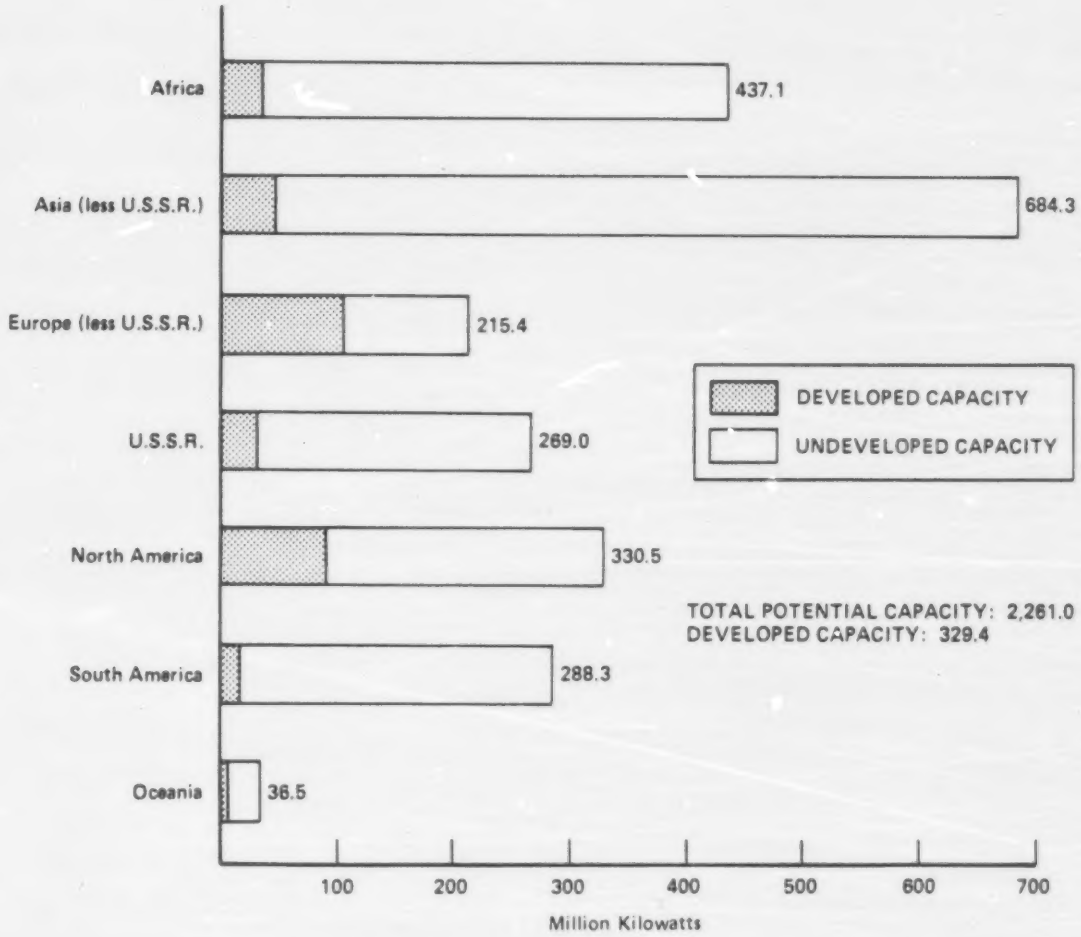
Hydropower

Hydropower appears at first glance to be a very much underdeveloped energy resource, evidenced by the bars on Figure 13 which show that less than 14 percent of the world's hydropower potential is being utilized. Undoubtedly, more could be done and will be done toward utilizing this simon-pure, non-polluting power resource. But there are problems, most of them stemming from the fact that in the underdeveloped regions the prospective sites are often nowhere near a market for their output, whereas the developed countries are haunted by land-use conflicts and environmental inhibitions. In the United States we look for a continued slow growth in hydropower, with its share in the energy balance continuing to diminish as other sources expand more rapidly.

Geothermal Energy

Geothermal energy suffers the problems of place that apply to hydropower, which limit its contribution to the localities in which geothermal occurrences are found. Geothermal energy heats the entire city of Reykjavik, Iceland, and is used to produce electricity in a half dozen countries, including the United States, where a 500-megawatt installation in Northern California supplies electricity to San Francisco. Geothermal is therefore a current asset. It is here now, at least that part of it manifested as hydrothermal convection systems which can be tapped for steam or hot

FIGURE 13
World Hydroelectric Power, Developed and Underdeveloped, 1973



Source: Survey of Energy Resources, World Energy Conference, 1974.

water. The Geological Survey last year published estimates that a potential of 11,700 megawatts of electrical capacity over a thirty-year period is now commercially recoverable from these sources, all in the Western part of the country. This is the thermal equivalent of 350,000 barrels a day of oil used for power generation purposes—not large in the national context, but important to the localities where these resources occur. Undiscovered hydrothermal systems, if found and developed, could increase these totals by a factor of three. In addition, a considerably larger amount of low-grade heat is also recoverable for space heating and cooling and purposes other than electrical generation. In the future we may be able to recover the much larger potential energy available from hot dry rocks associated with some 11 young volcanic systems in the Western states, and particularly from the geopressured zones along the Gulf of Mexico—which also contain large amounts of dissolved methane. We are aware of the outstanding work which has been done by the scientists and engineers of this University—work which has advanced the utilization of the potentially vast geothermal resources of the Gulf Coast area.

Conclusions

The conclusions to be drawn from all this are so obvious they hardly need repeating, but I'll do it anyway. Both the U.S. and the world have an immense amount of coal, many times current production, and sufficient for many decades into the future at any consumption rates we can realistically foresee. The major problems are in utilization, not production. There is enough oil and gas in the world to bridge over the next couple of decades provided it is equitably shared and energetically explored for and developed. Much of the present reserve is in and around the Persian Gulf. At home, we have used a good bit of our petroleum patrimony, but enough remains to justify an ambitious program to find and produce it. Oil shale and tar sands are abundant, but await the solution of certain extraction and processing problems. Uranium has only a limited future as a fuel for the present generation of reactors; in breeders, its potential goes up a couple of orders of magnitude, added to which will be the large but ill-defined contribution of thorium. Hydropower and geothermal are likely to be restricted, but nonetheless very important to the regions and localities in which they occur and can be developed.

Finally, there is the reality that our present data on energy resources leave much to be desired, and the probability that many if not most of our estimates understate the volume of energy resources that actually exist.

In short, the physical resources are available in plentiful supply to carry us through the period of transition from non-renewable energy sources to a reliance on the inexhaustible energy of the sun and the virtually limitless energy of the fused atom. The limiting factor is not geology but technology, economics, and above all, politics—all instrumentalities of human creation and subject to human management and control. There are no insoluble problems. We can do whatever we have to do. And it's time we got on with the job.

Energy Technologies: Status and Relative Economics

Dr. Herbert H. Woodson
Chairman of the Department of Electrical Engineering

(Dr. Woodson wishes to thank Dr. Claude R. Hocott for his collaboration in the preparation of this paper.)

Introduction

In this presentation we will give our views on the energy technologies that will be used in the future and the reasons behind these views.

For any technology to be used extensively, there must be an adequate fuel supply. Hence, before we discuss technologies, let's consider the potential supplies of energy fuels of different types.

Figure 1 shows estimates of the world's ultimate supply of fossil fuels and uranium 235. These are substantially greater than the economically recoverable reserves that Dr. Fisher was talking about earlier. The vertical scale is measured in units of Q(1Q = 10^{18}BTU). To put this in more recognizable terms the expected world energy consumption in the year 2000 is approximately 1Q. Hence, in terms of that measure, natural gas represents 10 years' supply at the expected world consumption rate in the year 2000; oil is 13 years' supply; oil shale and tar sands, 20; uranium 235, 70; and coal, 170.

Figure 2 contains the information from Fig. 1 plus the relative consumptive use in percent of each resource. Note that for the world, 38 percent of the energy was supplied by coal, 40 percent by oil, 20 percent by natural gas, and 2 percent by hydro. The information in Fig. 2 is for 1968; the figure for 1975 would be only slightly different—the principal difference being that about 3 percent of the world's energy was supplied by uranium.

The key message of the information in Fig. 2 is that we are consuming our scarcest energy fuels, oil and gas, most rapidly. This relative scarcity, plus the fact that it is getting more expensive to find and produce oil and gas, will drive their prices up. This will cause an increase in the rate of consumption of coal and uranium 235 with small contributions from other sources.

The alternative energy sources most talked about include the so-called non-depletable sources listed in Table 1. Geothermal energy, which is used already in several parts of the world, can supply a small amount

FIGURE 1
World's Ultimate Supply of Fossil Fuels, Uranium 235, and Hydro

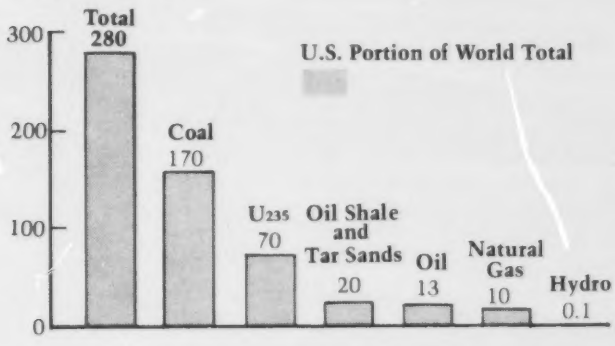
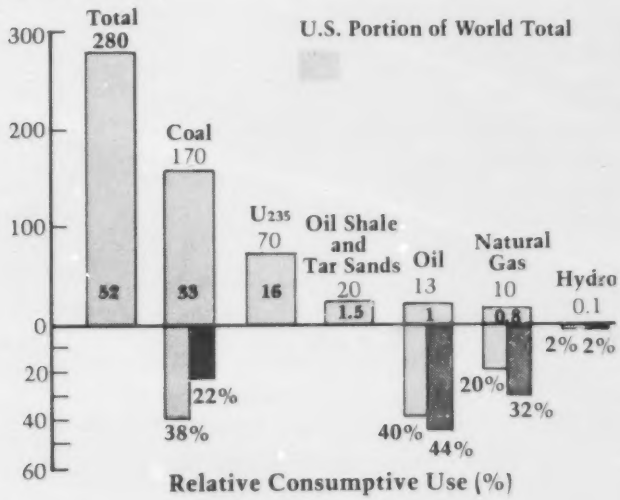


FIGURE 2
World's Ultimate Supply of Fossil Fuels, Uranium 235, and Hydro with Relative Consumptive Use of Each Source



of the world's need because it can be extracted economically in very limited geographic regions. The wind does not blow hard enough or persistently enough over a large enough fraction of the earth to be a sizeable energy source. Tidal energy is available over limited areas and is uneconomical because of the relatively small head that can be developed.

As indicated in Table 1, solar energy received by the earth amounts to more than 5,000 times the expected world energy use rate in the year 2000. Can we really use solar energy as a major source for society? This question will be answered later.

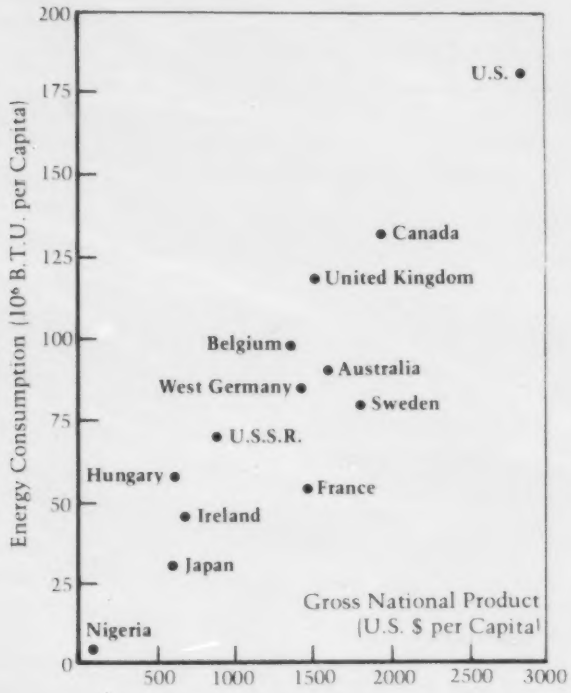
Two so-called depletable energy resources are also listed. The fast breeder reactor, which does not have to be liquid-metal cooled, can provide 420,000 times the world's expected energy requirement in the year 2000 by consuming not only uranium 238 but also the thorium that Dr. Fisher referred to. It is a fact that the first electric energy ever generated in the world with energy from nuclear fission was generated in the United States by a breeder reactor. It is also a fact that commercial-scale breeder reactor power plants are operating in France and Russia. In our opinion the breeder reactor is the only large-scale energy supply that mankind can depend on for the long-term future.

TABLE 1
Non-depletable and Depletable New Energy Sources Yet to Be Tapped

Non-Depletable (Per Year Basis)	
Geothermal Energy	0.009Q
Wind Energy	0.003Q
Tidal Energy	0.09 Q
Solar Energy	5.190Q
Depletable	
Liquid Metal Fast Breeder Reactor *	420,000Q
Fusion (D_2 from Oceans)	10,000,000,000Q

**Regardless of cost of mining*

FIGURE 3
Energy Consumption Per Capita versus Gross National Product Per Capita for Selected Countries



Fusion, about which more will be said later, consumes deuterium, which is a heavy isotope of hydrogen, and which is found in all the waters of the earth. This source could supply 10 billion times the world energy demand in the year 2000, which makes it essentially inexhaustible. We do not yet know how to produce fusion power in a controlled and reliable way; research continues and success is expected, but not soon.

To summarize in terms of energy sources we think will be used in the future, we will continue to use substantial amounts of oil and gas with dramatically increasing contributions from coal and uranium between now and 2000 and beyond. Fusion should begin to contribute measurably near the end of the first quarter of the next century. Solar and geothermal will make small contributions where they prove economical, but their overall impact will not be great.

One final comment by way of introduction concerns the information presented in Fig. 3 which shows the energy consumption per capita on the vertical axis and the gross national product (GNP) per capita on the horizontal axis for the countries indicated. We believe the economists when they tell us that the average real wages for workers are increasing slowly but steadily. This means that gross national product per capita will increase for most countries. The high price of energy will motivate conservation measures that will tend to decrease the energy consumption per unit of GNP. Hence, with time the points on Fig. 3 should move vertically downward and to the right.

In our opinion, the world standard of living will continue to improve, and more energy will be consumed, but it will be consumed more efficiently.

Conservation

We feel that conservation will be practiced widely in the form of more efficient use and fuel substitution to conserve scarce resources. These practices will be primarily motivated by economics and national interest. We do not believe that conservation in the form of curtailment will be practiced widely because it is our belief that people are reluctant to give up their comforts and conveniences unless forced to by economics or government regulations.

To be specific about how conservation will be practiced, an example is shown in Fig. 4. These are vehicles, used by the United States Post Office to collect mail from boxes scattered around town. The vehicle

FIGURE 4
Conventional Gasoline-Powered (left) and Experimental Battery-Powered Vehicles for Postal Service

must travel 12 to 15 miles per day at a speed never exceeding 35 to 40 miles per hour. The vehicle on the left is a conventional, gasoline-powered jeep; the one on the right is an experimental, battery-powered vehicle which can perform the same function. The use of battery-powered vehicles of this sort conserves scarce resources because their energy comes from abundant and inexpensive coal and nuclear by way of electricity and reduce the demand for liquid petroleum. Because the batteries in these vehicles can be charged off-peak at night, their use can help electric utilities improve their load factors and hence how efficiently they use their capital-intensive equipment for power generation. Other uses of electric vehicles will likely be light urban delivery service and a second family car for running local errands.

One of the large uses of oil and natural gas is for heating of homes and buildings. Figure 5 shows a heat pump which consumes electricity and provides heat. The overall thermal efficiency from primary fuel at the power plant to heat into the building is often better for a heat pump system than for a direct-fired oil or gas furnace. The use of a heat pump, which is essentially a refrigerator run backwards, can afford a fuel substitution of abundant and inexpensive coal and nuclear fuels for scarce and expensive oil and natural gas.

The heat pump is already widely used for both heating and cooling of homes and buildings and its use is increasing rapidly. Heat pumps are being developed for

FIGURE 5
An Electric-Powered Heat Pump for Residential Use

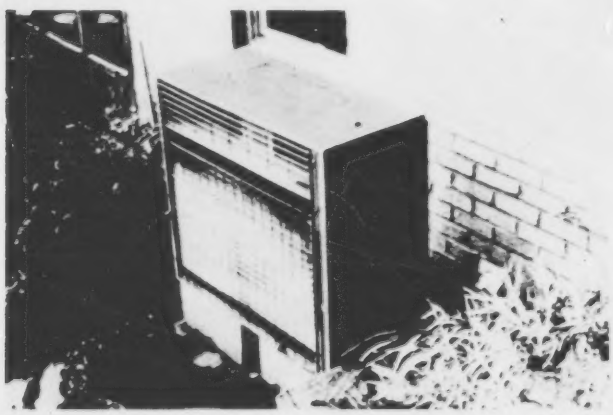
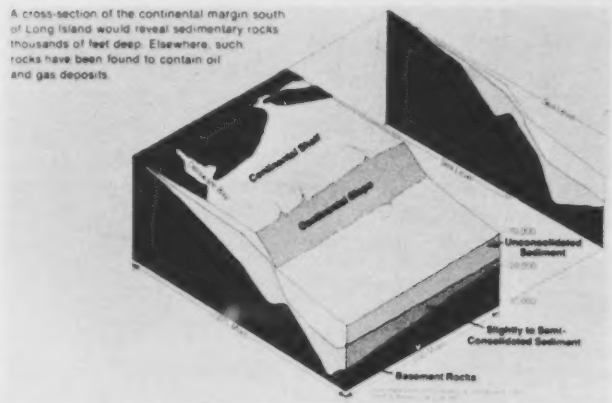


FIGURE 6
Typical Off-shore Profile


A cross-section of the continental margin south of Long Island would reveal sedimentary rocks thousands of feet deep. Elsewhere, such rocks have been found to contain oil and gas deposits.
Unconsolidated Sediment
Slightly to Semi-Consolidated Sediment
Basement Rocks

supplying industrial process heat and process steam, but their widespread use is further in the future. In our opinion, heat pump technology will be important in effecting fuel substitutions that will reduce demand on world supplies of oil and natural gas.

Oil and Natural Gas

Now, turning to energy supply technologies, let's look first at oil and natural gas. Figure 6 shows schematically a typical off-shore profile including continental shelf, slope, etc. In the past, oil and gas have been found and produced mostly onshore and in shallow offshore water. Activities will move to greater depths and more hostile environments such as in the Arctic, and we expect technology to be developed for the exploration, drilling, and production in these areas.

Exploration methods are improving steadily. Technological advances are being made in seismic methods, both in the acquisition and in the processing of data. It is possible in many sedimentary sections to detect and delineate stratigraphic traps as well as geologic structure. Moreover, interpretive techniques in current use can differentiate between gaseous and liquid accumulations in porous zones. In response to the need, technological advances permit the detection of geologic structures to ever-increasing depths.

The technologies for drilling and production of oil and natural gas are advancing along three lines. First, drilling and production in deeper sedimentary basins

FIGURE 7
A Drilling and Production Platform in the Gulf of Mexico

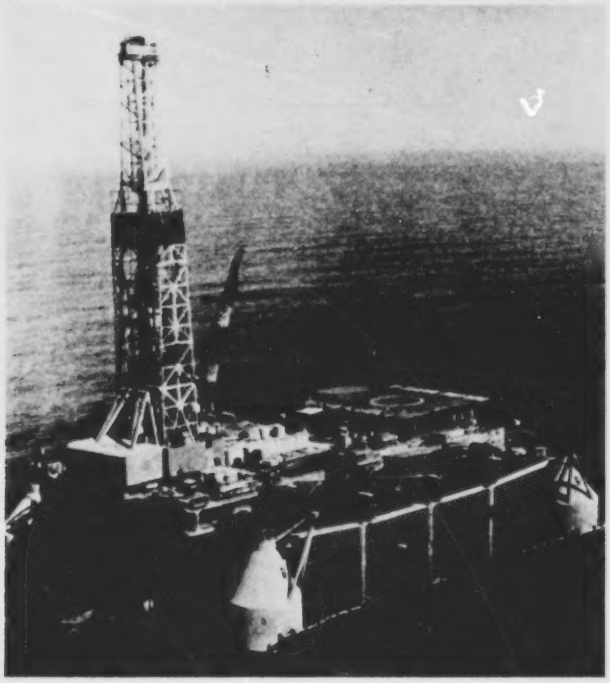


FIGURE 8
A Drilling and Production Platform in the Persian Gulf

where higher temperatures, higher pressures, increased salinity of waters, and increased occurrence of sour (sulfide bearing) oil and gas impose requirements for new and better materials for drill pipe, well casing, drill bits, drilling fluids, lubricants, and cements. These requirements are being met by vigorous technology development activities.

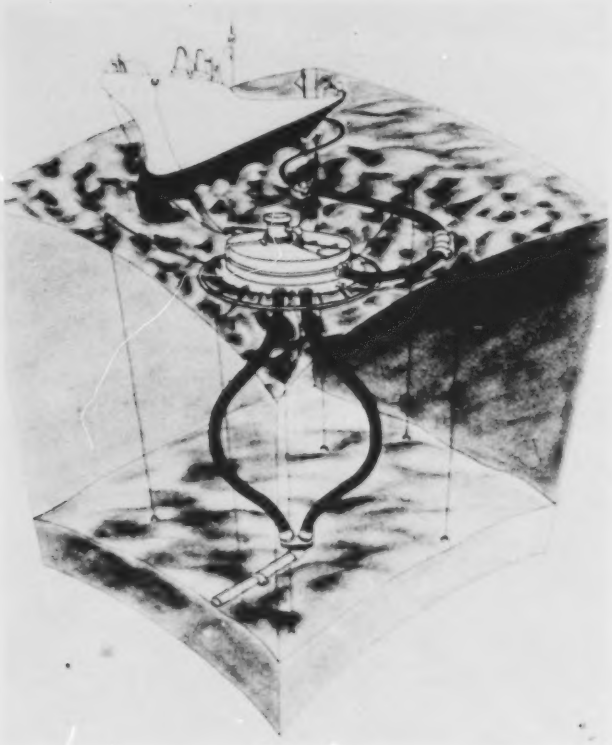
Second, drilling and production offshore in deeper water require further advances in technology. As examples of offshore platforms used, Fig. 7 shows one in the Gulf of Mexico, and Fig. 8 shows a drilling and production platform in the Persian Gulf. Present technology allows drilling and production in water to a depth of 1000 feet; and it appears extendable to the range of 2000 to 3000 feet. To go deeper, innovations are needed, and expectations are that they will be forthcoming and allow drilling and production in water to a depth of 6000 feet by the last decade of this century.

Third, technologies for drilling and production in the Arctic for land areas and for the shallow Arctic continental shelf of shorefast ice appear to be well in hand. Operations in deep water with mobile ice will be much more difficult and will probably not be practical for 25 years or more.

In the area of oil recovery, as Dr. Fisher has indicated, we do not recover all of the oil in place. Oil recovery has been enhanced successfully for a long time by the use of explosives and acidizing. More recently, hydraulic fracturing has become practical for many reservoirs. In known deposits of highly viscous oils where recoveries were in the range of 5 to 15 percent, thermal methods, steam injection or in situ combustion, are being used under favorable reservoir conditions to enhance recovery.

Older reservoirs that were produced prior to the era of modern reservoir engineering achieved poor recovery, and large quantities of oil remain following pri-

FIGURE 9
Schematic of a Deepwater Port for Supertankers



mary and secondary production. Intensive research and development on tertiary recovery are being done to make this oil recoverable. The more common techniques being studied are hydrocarbon miscible, carbon dioxide, thickened water, and surfactant solutions. Systems have been devised for each method to recover significant quantities of oil, but, to date, they are all uneconomic due to the high cost of materials and labor. Work continues and the hope is that success will occur in the time period 1980 to 2000.

Oil and gas transportation technologies are readily available for most situations; but the more hostile frontiers of the Arctic and offshore call for extensions of present technology. The laying of pipelines in permafrost areas or in the deep-water, high-wave areas such as the North Sea imposes new problems and extremely high costs, and innovations are sorely needed.

Deepwater terminals both for loading production and for offloading at major refining locations for supertankers should readily keep pace with drilling and production activities. Production from individual wells is fed under water into a single service platform and then to a buoy for transfer to tankers.

Figure 9 shows a sketch of a deepwater port for unloading supertankers. These can be developed and deployed economically when needed. The biggest drawback is the possibility of major oil spills but adequate technology can prevent that.

Refinery technology is well developed and only evolutionary changes are expected. The major change in refining technology is expected to occur in expanded capability for desulfurization needed to produce petroleum products that can meet stricter environmental standards on sulfur-oxide emissions.

Coal

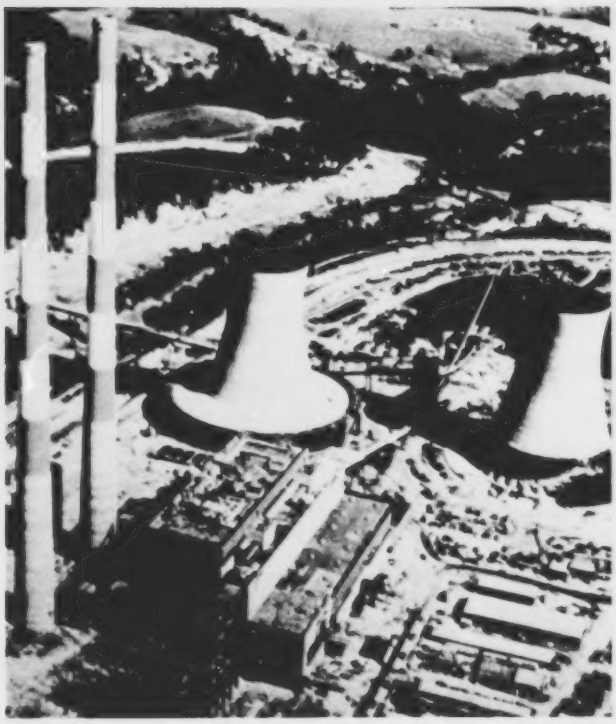
Underground mining of coal produces an economically competitive fuel with current technology. Further technological advances will be made in the areas of health and safety for miners and in the automated digging and extraction of coal from the mine.

Surface mining, or strip mining, of coal or lignite requires technologies that are relatively mature although evolutionary changes are being made, primarily in the direction of larger scale to achieve economies. Larger draglines allow economical stripping to greater depths and hence make available more coal and lignite.

Long-distance coal transportation has been accomplished by barge where possible because it is the most economical. Otherwise unit trains have been used. Some slurry pipelines have been operated successfully and economically; and, as the use of coal is expanded, we expect to see the increased use of slurry pipelines.

Coal and lignite will be consumed almost entirely by direct combustion to produce process heat, process steam, and steam to drive turbine-generators to produce electricity. Stack-gas cleanup to remove particulate and gaseous pollutants will be used to achieve the air quality desired, consistent with economic production of useful energy. Figure 10 shows a two-unit, 2600 megawatt, coal-fired power plant with natural draft cooling towers and tall stacks to disperse the small emissions remaining after stack-gas cleanup.

FIGURE 10
A Two-Unit, 2600-Megawatt Coal-Fired Power Plant in the Eastern U.S.



Synthetic fuels, both liquid and gases, will be too expensive to compete with direct combustion and stack-gas cleanup. Synthetic fuels, in our opinion, will only be used when there is no alternate form acceptable.

Stack gas cleanup technology is composed of two parts. Particulate emissions are reduced mostly by the use of precipitators such as the one illustrated in Fig. 11. Cyclone devices and bag houses are alternative technologies less widely used.

The second part of stack-gas cleanup technology is that for removing oxides of sulfur. Currently this is accomplished mostly by lime or limestone scrubbers such as the one illustrated in Fig. 12. These scrubbers produce a sludge which is virtually useless and which must be disposed of in an environmentally acceptable way. We believe that these sludge-producing scrubbers will, in the next decade, be replaced by regenerative scrubbers that produce either elemental sulfur or sulfuric acid, both of which are valuable industrial chemicals.

An alternative for producing clean energy from coal is technology, such as solvent refining, to produce a clean-burning, solid hydrocarbon fuel. The hope is that an economical system can be devised with several environmental advantages.

FIGURE 11
An Electrostatic Precipitator

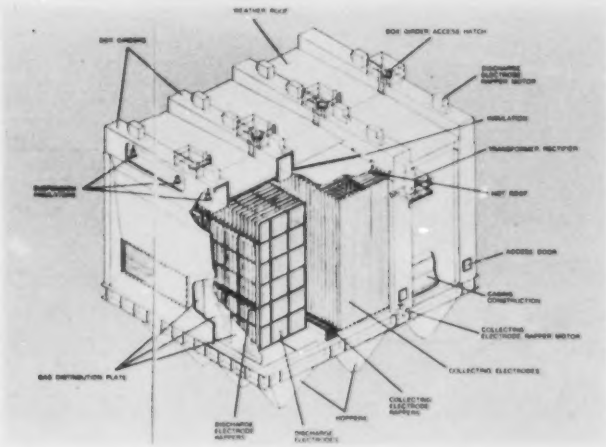
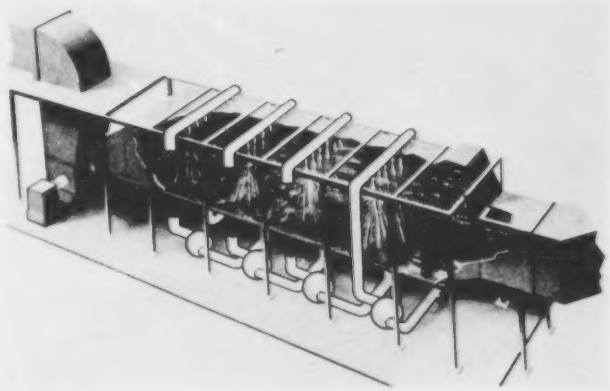


FIGURE 12
A Wet Scrubber for Removal of Sulfur Dioxide from Stack Gases



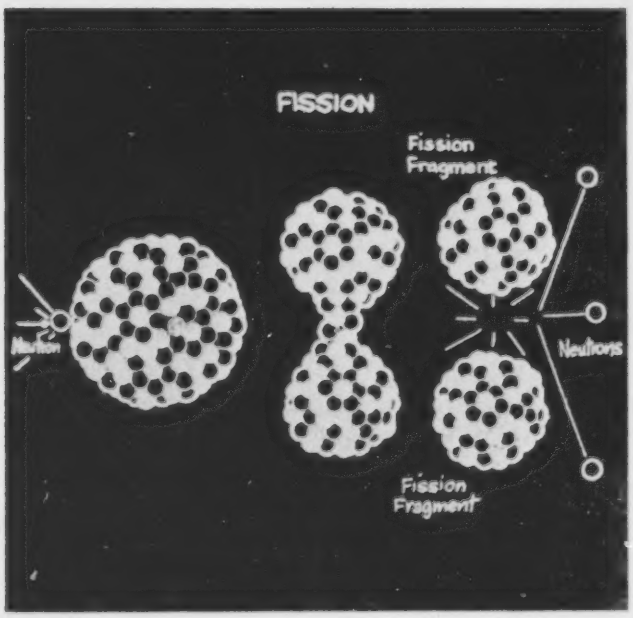
In summary, we believe that it will be economical to consume coal by direct combustion with stack-gas cleanup to achieve the level of air quality desired: Synthetic fuels from coal will not compete economically and will only be used when there is no acceptable alternative to that fuel form.

Nuclear Fission

Nuclear fission occurs by the process illustrated in Fig. 13. An atom of fissionable material such as uranium 235, uranium 233, or plutonium 239, is struck by a neutron and fissions or splits into fragments. In the process, more neutrons are released than were required to cause the reaction and net energy is released.

The energy released is in kinetic energy in the neutrons which must be moderated or slowed down to change the kinetic energy to thermal energy, and then the energy must be transferred from the reaction zone to where it is used or further converted. Thus reactor types are specified according to how the neutrons are moderated and how the heat is removed from the reactor.

FIGURE 13
Illustration of the Fission Process



Nuclear fission had its earliest substantial development in the United Kingdom with the graphite-moderated, gas (carbon dioxide) cooled reactor (GCR). Although the United Kingdom has also developed an advanced gas-cooled reactor (AGR) with graphite moderator and carbon dioxide coolant to operate at higher temperatures and improved efficiency, there do not appear to be plans for further deployment.

Further gas-cooled reactor development is proceeding with helium as the coolant and with heavy water or graphite as the moderator. The advantage of helium is its inertness at elevated temperatures. The high temperature gas-cooled reactor (HTGR) has been demonstrated in both the UK and the US.

The gas-cooled reactor can operate on a thorium 232, uranium 233 cycle which both makes available the large energy resource of thorium and avoids the problems associated with plutonium. A thorium high temperature reactor (THTR) is under construction in Germany and is scheduled for operation in 1977.

The HTGR's, because of their high temperature operation, can readily provide process heat for such things as steelmaking and synthetic fuels from coal. Also, direct-cycle gas turbines with either dry cooling towers or with vapor bottoming cycles promise high thermal efficiency.

Light water reactors (LWR's) in which ordinary water both moderates the neutrons and removes the heat, dominate the world market. LWR's fall into two categories: the boiling-water reactor (BWR) in which steam is produced in the reactor core; and the pressurized-water reactor (PWR) in which heat is removed by liquid water under high pressure, and steam is produced by heat exchange external to the reactor.

The reactor types described thus far require enriched fuel. The only fissionable material that occurs in abundance naturally is uranium 235 which occurs as about one part in 140 in natural uranium, the remainder being uranium 238. For use in the reactors described, the fraction of uranium 235 must be increased to about three percent. This fuel enrichment can be accomplished in one of several ways. Gaseous diffusion and centrifuge techniques are the two methods commercially used at the present time. Nozzle and laser enrichment techniques are being developed.

In Canada, a pressurized heavy water reactor (PHWR) has been developed and deployed. The principal advan-

tage of this reactor, called the Candu, is that it uses natural uranium and hence requires no enrichment, a capital- and energy-intensive process. The capital cost of the Candu reactor is, however, substantially greater than for the reactors that use enriched fuel.

The U.S.S.R. supplies its own reactors and uses both the PWR and a graphite-moderated, light-water-cooled reactor (LGR).

PWR's, BWR's, and GCR's represent the bulk of present nuclear generating capacity. The BWR and PWR appear to represent most of the currently planned additions, but the HTGR and the PHWR will probably gain a larger share of the market at a later date.

To illustrate some of the processes and equipment of nuclear fission energy, uranium oxide fuel elements are placed in thin-walled tubes to form fuel rods which are then assembled into fuel bundles. These fuel bundles are then combined with other apparatus to complete the fuel assembly which is placed in the reactor vessel. Figure 14 shows a reactor vessel being set in place. Finally the reactor vessel is enclosed in the reactor housing, two of which are shown in Fig. 15 in which the unit on the right is complete and the unit on the left is under construction.

Another type of nuclear fission reactor is the breeder reactor whose major feature is that it produces more fissionable material than it consumes by converting fertile material to fissionable material. Examples of fertile material that can be used to fuel breeder reactors are uranium 238, the principal constituent of natural uranium, and thorium 232 which Dr. Fisher has identified as abundant.

The types of breeder reactors being studied and used currently are the liquid-metal-cooled fast breeder reactor (LMFBR), the gas-cooled fast breeder reactor (GCFR) and the light-water breeder reactor (LWBR). The LMFBR has received the most support and is thus the most highly developed with commercial-scale plants operating in France and Russia and a demonstration plant in Britain. It is ironic that the first electric power ever generated by a fission reaction was by a breeder reactor in the United States, yet the U.S. is far behind the rest of the world in the development of a commercial breeder.

Fuel reprocessing is needed for all types of fission reactors, to recover unburned fuel in thermal reactors, to recover bred fuel in a breeder reactor, and to separate

FIGURE 14
A Reactor Vessel for a Nuclear Power Plant

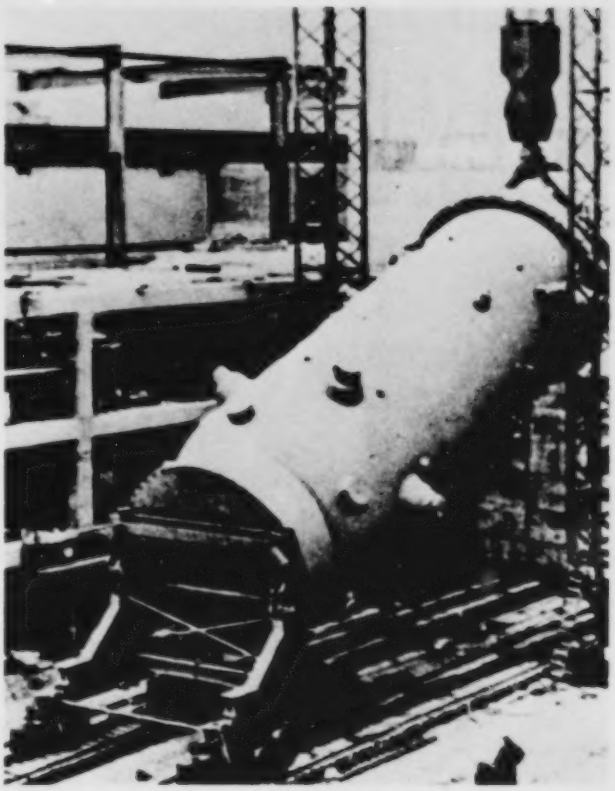
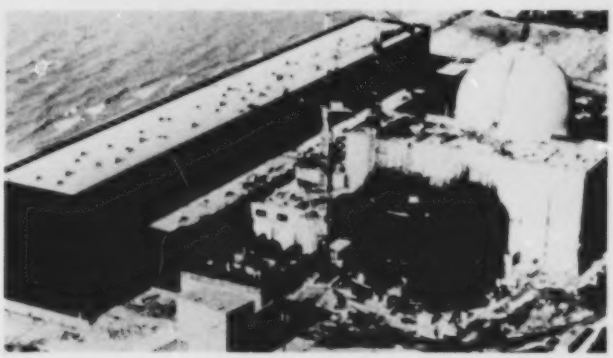


FIGURE 15
A Two-Unit Nuclear Power Plant Located on the Eastern Shore of Lake Michigan



out radioactive wastes for disposition. Reprocessing of metallic natural uranium fuels from gas-cooled reactors is done on a routine commercial basis in the United Kingdom and France. Reprocessing of highly-irradiated oxide fuels is not yet commercial, but pilot scale operations are underway and successful and full-scale commercial plants are expected in the early 1980's.

Radioactive wastes that are separated out in fuel reprocessing must be kept out of the environment indefinitely. The preferred process is to solidify the wastes into a glass-like solid to render them highly stable. After glassification the wastes can be stored and maintained safe in some form of retrievable surface storage, or they can be disposed of permanently in geologically stable formations. The latter is the preferred method in the U.S. currently. We prefer retrievable storage because we feel there is a high probability that technology can be developed in the future to transmute the radioactive wastes and render them harmless.

In summary, it is our opinion that nuclear fission will be one of the major energy supplies for mankind into the indefinite future, first from thermal reactors and later (in the 1990's) from breeder reactors. The breeder reactor provides the only assured, large-scale, economic source of energy for the indefinite future.

Geothermal

Geothermal energy comes from the hot core of the earth and, as Dr. Fisher indicated, can occur in several forms: dry steam, hot brine, geopressured hot water, and hot dry rocks. Figure 16 shows the worldwide distribution of hydrothermal resources. The only com-

FIGURE 16
Worldwide Distribution of Hydrothermal Geothermal Resources

Figure 2. Colored dots indicate the major high-temperature hydrothermal areas of the world. Most are located in regions of current or recent volcanism or tectonic activity.

mercial production of geothermal energy in the United States occurs at The Geysers, north of San Francisco. This field produces dry steam that can be used directly to drive turbines. This field produces highly economical electric energy that is fed into the system of the Pacific Gas and Electric Company. With vigorous development The Geysers can, at most, supply about 10 percent of PG&E's energy. Thus geothermal energy supplies an important fraction but does not justify ignoring other supplies.

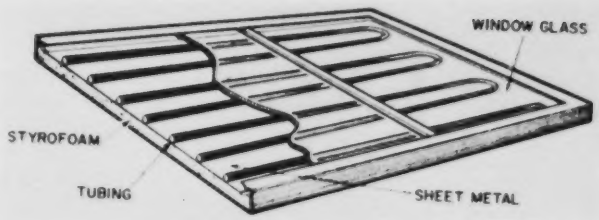
The Wairakei geothermal field in New Zealand also produces economical energy. There are other operating geothermal fields, notably in Iceland and in Italy. It is expected that developments will occur to make hot brine and geopressured resources economical, and the same may happen for hot dry rocks, but the prospect is much less certain. Nonetheless, even with maximum success, geothermal can make only a small contribution to the world's energy supply because it will be economically attractive over such a small fraction of the earth's surface.

Solar

As was indicated earlier, solar energy reaches the earth at an average rate equal to more than 5000 times the expected world energy consumption rate in the year 2000. Whether or not some of this energy can be harnessed to serve mankind's specialized needs remains an open question, primarily of economics, yet to be answered by the results of demonstration projects currently under way or planned. In our opinion, some solar energy systems will succeed economically and others will not.

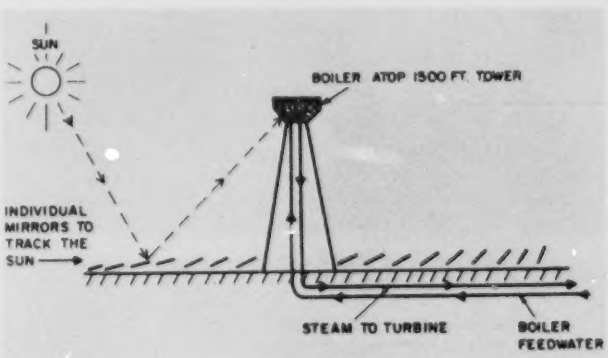
In our opinion, the solar energy systems showing the greatest chance for success are those producing low quality (low temperature and low pressure) heat. Temperatures of around 180°F can be produced by so-called flat-plate, fixed collectors such as the one illustrated in Fig. 17. This simple collector can be manufactured inexpensively and can produce temperatures entirely adequate for heating of homes and buildings and for heating domestic hot water. With an absorption refrigerator this low quality heat can also be used for air conditioning. There are a number of demonstration projects under way to explore the economics and performance of different collectors, different storage systems, and different heating and cooling systems. In our opinion solar heating will prove economical as a fuel saver, and cooling may also prove attractive, but it is much less certain. In any case, with maximum success for solar heating and cooling, it will supply no more than 3 to 4 percent of our energy needs. Incidentally there was a thriving solar water heater business in Florida in the 1930's until cheap natural gas was introduced and took over the water heating market.

FIGURE 17
Flat-Plate Solar Energy Collector



If large-scale electric power generation is to be achieved with solar energy, some form of concentration must occur to produce the high quality (high temperature and high pressure) heat necessary for efficient operation of turbomachinery. A number of schemes have been proposed, but currently the most economical system appears to be the one illustrated schematically in Fig. 18. In this system, a boiler sits atop a tower in the middle of a field of flat mirrors, each one of

FIGURE 18
The Power Tower Solar Energy System for Production of Electricity on a Large Scale



which is steered to reflect the sun's rays into the boiler. The technology to build such a system is available, but the true economics of the system must be determined from demonstration projects currently under way that will illustrate reliability, ease of maintenance, and other factors that strongly affect economics. We are not optimistic that this or any other scheme of large-scale electric power generation from solar energy will be economical compared to coal- and nuclear-fission-fueled power generation within the next 50 to 100 years.

In our opinion, the wind does not blow hard enough or persistently enough to make wind-generated energy economical except over very limited regions of the earth.

Figure 19 shows schematically the makeup of a photovoltaic cell. It is a specially doped slab of semiconducting material that directly converts solar energy to electric energy. It has proved of great value in space exploration, but its cost per kilowatt is 100 to 200 times that of coal- or nuclear-fueled power plants on earth. Hence research is needed and is being done to lower the cost of solar cells. We are not optimistic that success will be achieved, even over the long term.

Solar power generation using photovoltaic cells is even less competitive economically when accomplished using the system illustrated schematically in Figure 20. In this system, a synchronous satellite, which stays fixed with respect to a fixed spot on the surface of the earth, carries solar cells that produce electric energy which is converted to microwave energy, beamed to a receiving antenna on earth where the energy is converted to the frequency correct for feeding into a power transmission system. This system is technically feasible and provides a major justification for the U.S. space shuttle program; but, in our opinion, it will not prove economical as a large-scale source of electric energy for a long, long time.

There are places in the oceans where sizeable temperature differences (20 centigrade degrees) occur over vertical distances of a few hundred meters. The so-called ocean thermal conversion system is intended to extract energy from this temperature difference. The thermal efficiency of a system operating at these temperatures would be so low that relatively large amounts of water would have to be pumped through very large heat exchangers to extract a relatively small amount of

FIGURE 19
Schematic of a Solar Cell

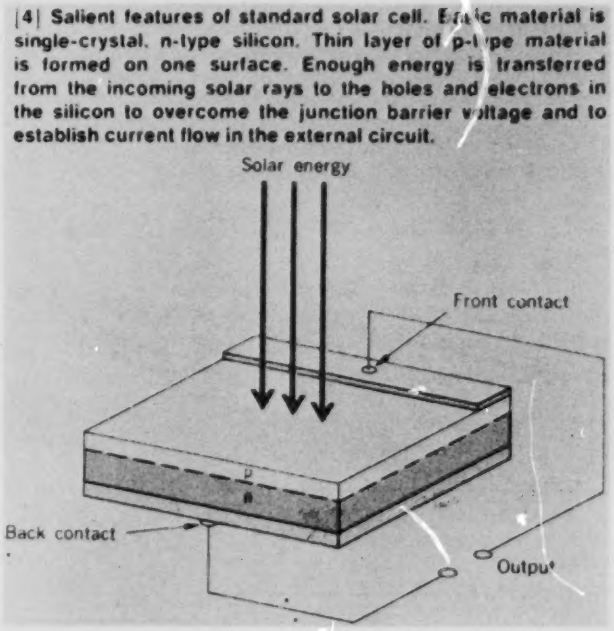
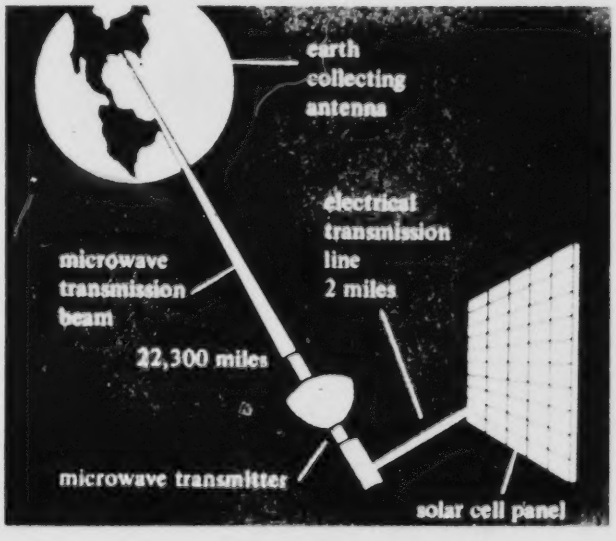

[4] Salient features of standard solar cell. Basic material is single-crystal, n-type silicon. Thin layer of p-type material is formed on one surface. Enough energy is transferred from the incoming solar rays to the holes and electrons in the silicon to overcome the junction barrier voltage and to establish current flow in the external circuit.
Solar energy
Front contact
p
n
Back contact
Output

FIGURE 20
Satellite Solar Power System



energy. In our opinion, the capital costs of such a plant would be so large that the plant would not be economical. This assertion is in the process of being tested by demonstration projects.

Municipal Solid Wastes

An energy source not yet discussed is municipal solid wastes. Wastes are processed to recover metals and other materials for recycling after which the remainder is made into a pelletized fuel that can be mixed in a small fraction (10 to 20 percent) with coal for burning in a coal-fired power plant. In our opinion, wastes can supply about 10 percent of the electric energy needs of an urban area, and the process will be economical, especially when it is given credit for its contribution to the solid-waste disposal problem.

Fusion

Fusion is the process in which light elements, such as isotopes of hydrogen, are thrown together with such force that they fuse and release energy. This process is illustrated for deuterium and tritium, two isotopes of hydrogen, in Fig. 21. The reaction products are helium and an energetic neutron.

In order to make the fusion reaction proceed, the reactants must be mixed, elevated to the temperature necessary to achieve the reaction, and held together long enough for the reaction to take place. How hot—100 million degrees centigrade which means no material container can be used to hold the reactants. Containment is achieved in one of two ways illustrated in Fig. 22. Three of the concepts illustrated, mirror, tokamak, and theta pinch, use magnetic fields for containment. The other concept is one in which a very short duration, very intense laser pulse is made to impinge on a pellet of solid reactants, heating them so rapidly that the fusion reaction can occur before the pellet has time to expand significantly. This is called inertial containment.

All of these concepts, as well as others, are being studied in many countries throughout the world. Research results are promising, and there is optimism that fusion can be successfully developed to be a large-scale, long-term, and economical energy supply; but much remains to be done, and the experimental devices are becoming increasingly expensive. For example, a physics experiment that has been recently au-

FIGURE 21
Illustration of Fusion Process

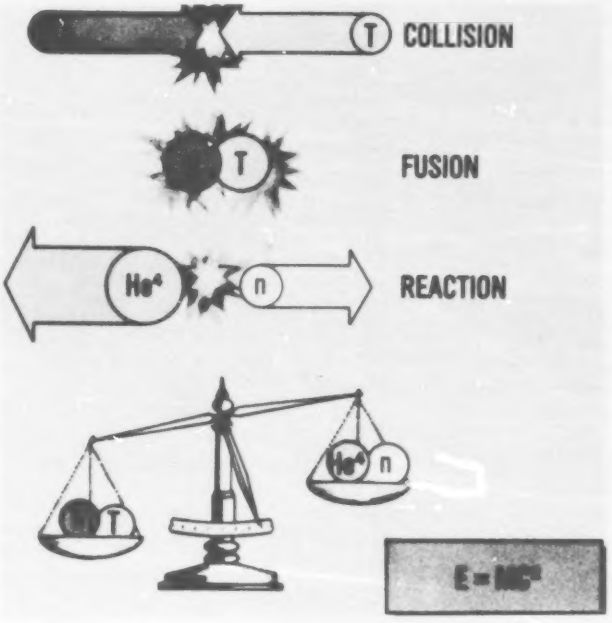
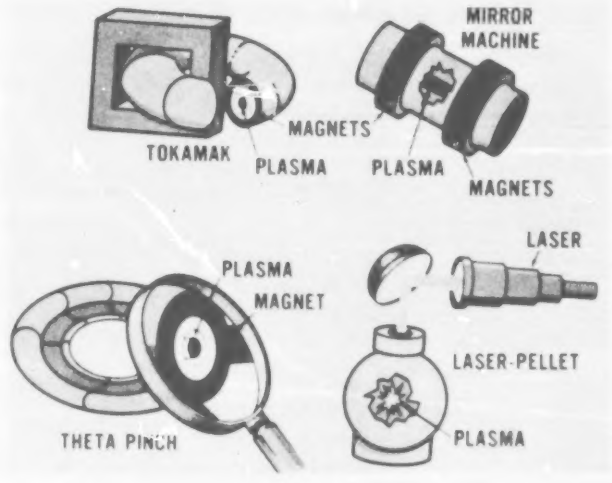


FIGURE 22
Confinement Concepts for Fusion Reactions



thorized by the U.S. Congress will cost $215 million to build. Two or three steps are required beyond this experiment before a demonstration of practical energy production can be made. For this reason we believe that the first production of electric energy by a fusion reaction will be around the turn of the century with significant contributions from fusion to the worldwide energy demand commencing about 2025 or later.

In our opinion, the potential rewards of fusion energy are well worth the enormous investments that must be made in research. The principal advantages that lead to this conclusion are:

1. There is effectively an infinite fuel supply in deuterium from water.
2. The deuterium can be separated from water quite inexpensively.
3. No one can control your fuel supply if you have water.
4. A fusion reactor has inherent safety with no runaway danger because fuel will be fed into the reactor only as fast as it is consumed.
5. A fusion reactor has the hope of less radioactivity problems than fission reactors. There are no radioactive reaction products but neutrons will render the structure radioactive.
6. There are no weapons-grade materials used so there is no danger of diversion.

Summary

In summary, we feel that the energy technologies of the future, along with the sources to be used, are as follows:

1. We will continue into the indefinite future to use large quantities of oil and natural gas, supported by a vigorous program of exploration, drilling, and production with advances in technology on all fronts. Oil and gas will, however, supply a decreasing fraction of the total energy supply.
2. We will increase our use of the solid hydrocarbons, coal and lignite, with improved technology for combustion and environmental protection. Most coal and lignite will be direct fired for industrial heat and steam and for electricity production. Synthetic fuels will be produced from coal and lignite only when that fuel form is absolutely essential.
3. Nuclear fission using both gas- and water-cooled reactors will experience increasing use to generate electricity and to supply process heat and steam. Thermal reactors will be used first, followed by breeder reactors later.
4. Small contributions will be made to the global energy supply by geothermal, solar, and municipal solid wastes although the local contributions may be large in isolated instances.
5. Although the breeder reactor is currently the only long-term, large-scale energy supply of assured performance and economics, we believe fusion will become practical in the next century and provide an inexhaustible, economical energy supply for mankind.

Finally, we feel that in spite of much gloomy talk to the contrary, the technology and resources are available to provide mankind with the energy to continue to improve the standard of living in the world into the indefinite future.

Discussion of McKetta, Fisher, and Woodson Presentations

Question: If we do have this potential and if the only problem is really the value system of mankind in determining how we're going to share and where we're going, how fast are we going to get on really with this idea of value systems in the world, or can you folks answer those kinds of questions at all?

Woodson: I refer you to the program on Thursday when the theme is energy and the quality of life. I think you will find that the speakers in that session will address themselves to that issue quite effectively.

Question: We have, of course, been talking about fossil fuels as a primary energy source. Fossil fuels for the most part, except for oil, go to secondary types of energy, especially electric in many areas. What percent of the total energy that we are using, let's say in the United States, is a fixed usage of energy–houses, heating, iron furnaces, and so forth–and what percent must be a moveable, transportable type of energy?

Woodson: Roughly 75% is fixed energy supply and 25 to 30% is transportation.

Question: I have two questions, Dr. Woodson. First, what do you think of what's going on in Germany about nuclear energy? Second, do you think, actually, the use of nuclear energy depends economically on the availability of renewing the enrichment of uranium 235 every 3 or 5 years?

Woodson: I hope I understand the first part of your question about what's going on in Germany with respect to nuclear energy. Are you referring to their thorium reactor?

Question: Yes, sir. What's your reaction to thorium reactors?

Woodson: A number of things are going on in Germany, including the development of a high temperature gas-cooled reactor with a gas turbine cycle which has the promise of not needing cooling water. A gas turbine can be operated to reject heat at a relatively high temperature in an arid area. The Germans are doing this. They're also building a thorium high temperature reactor which consumes thorium and breeds uranium 233 (which avoids plutonium in the fuel cycle). Is that what you were talking about?

Question: Yes, because there is a nuclear agreement between Brazil and Germany, you knew it?

Woodson: I'm sorry I didn't understand.

Question: It's an agreement between Brazil and Germany just together to explore nuclear energy.

Woodson: I'm aware of the agreement but I am not familiar with the details.

Question: Second question. I ask you if you think nuclear energy is actually less expensive now because it can be reprocessed every 3 or 5 years?

Woodson: Yes, I do. That opinion is based on some analyses that have been done for installations in the U.S. I think it is also true in Europe. If you add up all the costs of energy produced by a nuclear plant, the capital charges are substantially higher than for a fossil fuel plant, but the fuel costs are much lower. The real difference is that the nuclear fuel cycle cost, even with expensive uranium, is still rather low. I think for example, even if uranium cost $100 per pound—Dr. Fisher's slide cut off at a maximum price of $30 per pound—it would only increase the cost of the electricity by about ½ cent per kilowatt hour, which is pretty small compared to the price that most people pay for their electricity these days.

Question: Yes, I read something that uranium could be enriched every 3 or 5 years–isn't that so?

Woodson: You're talking about how often you replace the core?

Question: Yes

Woodson: We're talking about something like a 3-year residence time of the fuel in the reactor. About a third of the fuel is replaced each year.

Question: Isn't that because it becomes less expensive.

Woodson: That's not easy to answer simply because if the fuel is left in the reactor a short time not much of it burns up, and if it is left in too long it loses its performance.

An economic optimization is done to figure out what residence time—how long the fuel is left in the core—results in the minimum cost of electricity. This is what results from the present understanding of nuclear fuel management. I don't think I've answered your question. I am sorry. Try to ask it in a different way so maybe I can comprehend.

Question: I am just going to help our guest from Brazil a little bit with his question on the fuel cycle. I think he's asking you to summarize why the fuel cycle in a nuclear reactor produces so much lower cost energy compared to fossil fuel.

Woodson: Primarily, uranium produces much more energy per pound, for example, than coal does—one small fuel pellet is equivalent to a couple of tons of coal. There is not much of a materials handling problem to get a lot of energy out of uranium, and that's why it produces less expensive energy.

Question: The gentleman from Brazil was dealing with the fact that you recharged the core every 3 years and reprocessed the fuel. Is that not the reason the fuel cycle is more economic than fossil fuel?

Woodson: It is a fact that nuclear power is cheaper even if you don't reprocess the fuel. If you simply store it forever and use fresh fuel every time you reload the core, it's still less expensive. Now if you close the fuel cycle by reprocessing and recovering the useable fuel left, nuclear energy becomes less expensive still; but it is substantially less expensive even without closing the fuel cycle—even without reprocessing the fuel.

Question: I'd like to direct this question to Dr. Fisher.

At a recent energy conference, a comment was made that geologists' ability to forecast known reserves had a realiability somewhere between an economist and a meteorologist. I'd like to have your comment, since we are basing some of the action on reserves, on the reliability of the charts you displayed?

Fisher: Certainly there's a tremendous amount of subjectivity inherent in the process of reserve determination and even much more so in the case of resources. In the case of resources you are pointing out that we are really trying to measure the unknown, and in some cases, even the unknowable. So, yes it does involve a lot of pretty broad assumptions and different interpretations. In the case of reserves we do a reasonably good job. But it is fair to say that the same geologists and same petroleum engineers would sit down and work on the same data base and might commonly be 15 to 20% different in terms of how they make their determinations. And this is an interesting issue—the figures of resources and reserves we formerly talked about in reasonably mundane exchanges of information now have become political issues in this country. We are now charged with every discrepancy of reserve figures of under-reporting and over-reporting or what have you. The process of evaluating reserves and resources is inherently a subjective process based on imperfect data, to be sure; nonetheless, it's the best we can do in defining both reserves and resources, and we have to make the best with what we can do.

Question: For Dr. Fisher; you've shown that no doubt the majority of our recoverable resources are in coal and that most of the low sulfur coal is in the western U.S. In the western U.S. the mineral estate rests predominantly with the Federal government, with the Department of Interior specifically. What activity is going on in the Department of the Interior to encourage the development of this federally owned and regulated resource that there is no doubt is the most abundant? Why aren't we getting more western coal?

Fisher: You're correct in assuming the significance of the western coal in terms of Federal holdings up to as much as 80% either held under Federal ownership or directly controlled by virtue of the land pattern that exists. The Department has not leased any coal for almost 5 years.

There's been a moratorium established on it. Just a few months ago the Secretary of the Interior did adopt a new coal-leasing policy in the Department which will again offer coal on a competitive basis entirely. The first action to be taken on that will be a call for nominations by industry or any interested person or even negative nominations much as has been

done in the outer continental shelf leasing areas. That will be accomplished in the middle of next month, and we will get identification of those lands in which there is an interest. Let me summarize very briefly this policy.

We are in the process of adopting surface mining regulations that will apply to reclamation of western coal lands, and we're also adopting standards which would require the mining of coal held under lease over a particular period of time or else the lease would be relinquished.

McKetta: While you're on that topic, tell us about Sierra Club versus Department of Interior. Is that settled?

Fisher: No, the injunction against the Four Corners Mine was lifted, and the mining plans that were in the process of being approved when the suit was filed have been approved. The Supreme Court will be hearing later on this summer, we hope, on whether we need yet another environmental impact statement. We've done a programmatic—a subregional—site-specific EIS and now the charges are that we need a regional one. That's the issue before the Supreme Court.

Question: Is it correct to say that our most abundant resource has not been leased by the Federal government for a period of 5 years?

Fisher: That's true. There have been some short-term approvals. Bear in mind we have under lease 25 billion tons of Federal coal. The moratorium that was established on leasing coal has been in effect over the last 4 to 5 years. This allows us to work out a much better arrangement for leasing coal than we've done in the past. We need to get away from rank speculation, get away from the development of some of the coals that were environmentally and economically not the best, so the Department of Interior is developing a new policy. There is, though, a substantial amount of coal already under Federal lease.

Question: Dr. Woodson, from your statements about nuclear reactors, I infer that there are some differences between Canadian and European reactor technology and U.S. technology with regards to fuel processing, radioactive waste disposal, and some other factors. Could you highlight what the differences are as far as waste disposal problems are concerned?

Woodson: The people who have probably resolved their waste disposal problems to the greatest extent are the French, and they essentially glassify the radioactive wastes and store them in aboveground, retrievable air-cooled storage. There is monitoring to make sure they're safe. The French have developed the glassification procedure to a much greater degree of sophistication and commercial operation than we have or than the British have. There is a widespread preference for solidifying the radioactive wastes. If they are liquid in a tank and the tank leaks, the wastes can enter the environment. But if they're a very stable solid, then they're not going to wander anywhere. What you then do with them after solidification is a subject of some discussion. In this country the preference of the Nuclear Regulatory Commission and others is to bury the solidified wastes in a geologically stable formation. But that hasn't been decided finally yet either. Was there another part of that question?

Question: What I was specifically trying to get at was if there's any difference in the production of waste products as a function of the type reactor technology that's used. You made the comment that heavy water and light water reactors have different enrichment requirements. I was wondering if there is any difference in the waste product based on the type of reactor technology.

Woodson: There are small differences, but they are not really very significant. The differences in the fuel have to do with how much processing and enrichment you have to do to the fuel before you put it in the reactor and where you want to spend your money.

Question: You mentioned that by increasing the rate of recovery in known oil fields from 32 to 40%, we could double our reserves. I was wondering if you could expand just a little bit on how an 8% increase in production would double our reserves? Just a few of the figures on how that would work.

McKetta: The question is how can an 8% increase in production double our reserves.

Fisher: That increment of 8% is applied to the entire base of all the oil that we know is in place, plus a lot of fields that have already been abandoned. It's a simple matter of calculation in terms of the total amount of discovered oil in place. You simply add an additional 8% factor that would have the effect of doubling that reserve base. In essence we have 100 billion barrels of oil in Texas that are currently nonrecoverable, and we know where the oil is. If we would increase the percentage recovery by 1% we have an additional 1 billion barrels of oil changed from nonrecoverable to proven reserves.

Woodson: Well, Bill you're counting on going back into old fields that, according to earlier recovery techniques, have been depleted.

Fisher: Oh sure. You bet I am.

Question: My question is about the picture showing a boiler upstairs. It's about solar energy. I saw in the boiler, that's okay I think in the summer, but how can you do it in winter, or when the sun is obscured by clouds? How can you store the energy?

Woodson: That's one of the problems of solar energy: you can't depend on the sun shining all the time even during the day. So, whenever a solar energy system is analyzed, you have to include either storage or alternate supplies of energy that would supply the demand while the sun isn't shining. That's one of the economic penalties that the solar energy system has to pay. And it's just a fact of life.

McKetta: In the solar units there are as many as 30,000 or 40,000 different mirrors carefully computerized and aimed accurately at the boiler. My recommendation to all young students is to take electronics and control, because we're going to have to have thousands and thousands of people repairing these little electronic units.

Question: Can you get as big as 1,000 megawatt units from solar power, or will they not be as big as that?

Woodson: The ultimate unit sizes that are being talked about in these central-station solar schemes are about 1,000 megawatts. Now there's a 5-megawatt boiler that's been tested, there's a 10-megawatt boiler under construction, and of course the ratings will increase as the development program proceeds. A unit rating in the range of 1,000 megawatts will be needed if it's really going to be a competitive, large-scale source of electric power. Otherwise, if you want 1,000 megawatts and there are only 100-megawatt units available, you have to build ten of them, and the installed capacity in the U.S. right now is 450,000 megawatts.

Question: I just attended in California a geothermal conference, and I'm interested in geothermal because about 3% of the total imports of our country is for fuel oil to generate electricity. We in Central America have, right now, several small programs going on that need help in one way, and in another way we could give help to the scientists here in the states about new types of geothermal energy that could be studied right now, looking at the possibility that the United States might get that type of energy in the future. It would be just a suggestion, then, Dr. Woodson, if you could pass it on to your colleagues, that all the Central American countries are needing some kind of help in that respect.

Woodson: I'm not sure I understood the question. Could you repeat it for me, John?

McKetta: Are you interested in technical help or financial help or what?

Question: Actually any kind of help. In other words, we are not asking for, well let me put it this way, it is not a plea actually, just a suggestion, just a matter of mutual interest.

Woodson: The Energy Research and Development Administration has a rather extensive geothermal program in which they are looking at geothermal energy from the four different types: dry steam, hot brines, geopressured zones, and hot dry rocks. My suggestion is that you get in contact with those people and talk with them about their programs. They are interested in international cooperation in any of these energy developments where the cooperation can be mutually beneficial to your country and to ours. My suggestion would be that those are the appropriate people to get in touch with. I'm curious, is your geothermal resource different than one of those four?

Question: To some extent, yes. It is a brine, sodium chloride based brine of lower salinity than what you have in the Imperial Valley and at a very high temperature for that type of thing. We have about 600 degrees Farenheit right now in our reservoir. That's the only difference.

McKetta: Of course, on the other extreme you have volcanic action and many people don't know that Dr. Bergelen from the University of Delaware, as far back as 1938, spent a great deal of time in Nicaragua trying to find some means of recovering energy from volcanic action. So you have the two tremendous extremes that represent very large quantities of energy on your localized level, and I hope that we do have close cooperation technically because there are a lot of things we want to learn from you.

Question: In fact we have a unit producing energy from geothermal that just started three months ago. My question: is there research going on in predicting the behavior of a geothermal source here in this state?

Woodson: Yes, within the program of the Energy Research and Development Administration, there are rather comprehensive and complete programs in each one of these areas that I talked about. The only one that I have first-hand, detailed knowledge about is the study of the geopressured zone along the Texas Gulf Coast. There has been quite a bit of effort going into simulation of the reservoir to try to really engineer its production in the most efficient way. And if you're interested in that, you should try to contact Dr. Roy Knapp in our petroleum engineering department who is doing the reservoir simulation and Dr. Podio who is also worrying about other related aspects. The two of them are very active in worrying about how geothermal reservoirs perform.

Question: Several times during this morning's presentations I heard the word sophisticated technologies mentioned, which is most appropriate in a university setting. Unless I misread my program, I didn't see anybody addressing the problem of the adequacy of human resources to implement these sophisticated technologies. I wonder if you'd comment on the inadequacy or adequacy of our human resource base to do this.

McKetta: Would you define adequacy or inadequacy of human resources, and I will answer your question.

Question: Do we have enough people, well trained to implement these technologies, to meet our time schedule for getting self-sufficiency?

McKetta: We have enough people in almost every area except fusion. We really don't have enough people that are well enough trained to help us in the fusion area, and this is why this is a two-pronged attack. At the same time that we are spending money in fusion toward progressing and opening curtains on new knowledge, we're also spending a lot of money educating young men and women to be able to help us. In other areas, such as the basic sciences, the manpower supply seems adequate. Do you want to add something?

Woodson: Yes, I just wanted to comment on that. I think that we are, in many of our programs, more manpower limited than we are money limited. I think that in some of the areas we could use a lot more people more appropriately educated and trained to do the kinds of things we need to do, but that's what places like The University of Texas at Austin do, is tailor their educational programs to the needs, and hopefully we'll produce the people in the future that will supply the demand.

Energy Utilization Constraints: Financial, Environmental, and Political

The Honorable Frank N. Ikard
President, American Petroleum Institute

There's an old saying that facts have a way of outrunning thoughts. That small piece of wisdom could serve today as a description of the worldwide energy problem.

The *facts* are: There are more and more people in the world, and they are demanding better lives—demands that are rooted in energy.

But our *thoughts*—the ideas, proposals, and the programs to deal with the problems—are running far behind. As time slips away, it becomes more and more doubtful that we will ever catch up.

My subject is the limitations imposed on finding and using energy. The title has a quiet, academic ring to it. But let me assure you the topic is highly explosive. If we fail to meet the world's growing energy needs, we face the certain prospect of widespread social conflict and turmoil.

Call it the revolution of rising expectations. Or the evolution of discontent. Whatever you call it, it is a pressure cooker: a pressure cooker of frustration with the lid clamped tight. Policies that discourage energy development—particularly political policies—are simply tightening the lid on the pressure cooker.

The chief obstacles to energy growth are widely recognized.

First, one that we hear a great deal about these days, concerns financial limitations. How does cost influence energy choices? How much capital is needed to develop needed energy?

Second, environmental limitations. In a world requiring more and more energy, how can environmental problems be resolved?

And finally, political limitations—the impact of government actions. At what point do those actions become counterproductive?

All these types of limitations are interrelated to a

high degree. But the limitations imposed by government vastly overshadow the others in importance. They are setting the world farther and farther back in the race to keep up with peoples' needs.

Let me emphasize the thought that when we discuss energy demand, we are really talking about the wants and needs of people. All too often, we tend to think of a barrel of oil or a ton of coal as a commodity standing by itself—an item that countries simply need and use up. Or as items on an economist's chart.

But of course, energy cannot be separated from basic human wants and needs. Demand for energy starts with the needs of people—for food, better housing, better schools, clothing, and better transportation—the whole range of human hopes and aspirations. All these desires create a demand for energy use of one kind or another.

The desire of people around the world for more and better goods and services of all kinds has been increasing very rapidly. Over the past few years, to be sure, there has been some slow up. With the world price of oil increasing nearly five-fold, demand has slowed down. But now, factories are again turning out more goods, people are spending once more, and demand for energy is moving up again.

By 1985 or 1986—ten years from now—the world may need half again as much energy as we use today. Energy use in Europe and North America may double. Demand in the Far East may triple.

Many countries in the world are determined to pull out of dead-end economies and dependence on back-breaking labor. As they move toward modern, industrialized economies, energy demand will soar. African countries, for example, may need 50 percent more energy in the next five years. The same holds true for such countries as India and Spain.

How can we provide this energy? The more we look into this question, the more we realize that the choice is really very narrow.

Solar energy, for example, will probably not play any significant role in the total energy picture until the next century.

To be sure, some progress is being made. Components for solar heating systems are now being manufactured and used in Australia, Israel, Japan, the U.S.S.R. and here in the United States. But solar energy's greatest achievement to date is the light it has shed on the costs of its own development.

Enormous cost problems remain when it comes to large-scale projects, such as power plants for generating electricity. One recent study showed that the cost of a solar power station might be about ten times that of a conventional plant.

Another choice often suggested is tidal power. Tidal power is technically feasible; a tidal power plant has been operating in France for several years. But here again, the capital costs are a major deterrent. Geothermal power is limited by the number of available sites.

The fastest growing energy source in the future will be nuclear power. Around the world, only 162 plants are now operating. This is a small number when you consider the bright hopes for peacetime use of nuclear energy that were launched more than a quarter of a century ago.

Another 432 nuclear power plants around the world are still in the planning stage, or under construction. Many are being delayed.

Here in the United States, as elsewhere, the high cost has been a severe problem—a financial constraint. A company in the U.S. starting to build a nuclear power plant tomorrow might end up paying more than $800 million for it. Our nuclear plants have also run into strong opposition for environmental reasons. Similar experiences have been encountered in other countries. countries.

Now, what about coal? Coal was the leading source of energy in the world until the mid-1960's. In a number of countries, coal development has slowed for environmental reasons. However, if the world price of oil should rise too high for some countries, they may turn again to coal. If they can afford the investment, and solve the technical problems, they may convert coal to gas or liquid forms—forms considered less harmful to the environment.

This brings us to oil and natural gas—the major fuels in the world today, and very probably the major fuels for the rest of the century. They account for about three-fourths of the energy used in the United States, and about 60 percent of the energy used worldwide.

Over the next ten years, people around the world will need about three-fourths more petroleum than we've needed in the past ten years.

Government policies that discourage the search and development of that oil and gas are therefore heading our world into deeply troubled waters. For if the energy needs of the world aren't satisfied, there simply won't

be enough jobs, there won't be enough goods, there won't be enough food, and we would see the end of ambitious social goals. All this, in country after country.

Consider first the capital needs to supply that energy. According to estimates by the Chase Manhattan Bank, it will take capital and exploration investments of about $955 billion by the worldwide petroleum industry over the next ten years.

That figure of $955 billion is so huge, it's difficult to grasp. Let me try to put it in some perspective. It is more than the wealth produced last year by the United Kingdom, West Germany, France, Italy, and Japan—all put together. It's nearly 20 times the wealth produced in a year by India, and many more times the wealth produced by all the countries in Africa.

Whether it will be possible to make expenditures of that size depends, very simply, on whether they are profitable enough. Yet in any number of countries, governments are taking actions that reduce profits, or otherwise discourage investment in finding and producing more oil and gas.

In the past, those exploring for oil were willing to take the heavy risks involved in hunting for oil because the few successes balanced out the numerous failures. But today, they may make a discovery and then find the host country has suddenly changed the rules—some new taxes are in order.

Norway and Great Britain, for example, imposed new, heavy taxes when it became evident that the North Sea contained a lot of oil and gas. Australia discouraged investment by outsiders, a step that brought oil exploration to a complete stop. Fortunately that policy has now been reversed. Several countries—such as England and Norway—are forming oil companies that will get the first choice of exploration rights. That will surely discourage exploration by the private sector which, after all, will have to provide most of tomorrow's oil and gas. It can't be done by relying solely on state-owned companies.

However, in looking for examples of how government policies can impose severe financial handicaps, I really don't have to look beyond the United States. In recent years, the U.S. has, for example, imposed these constraints:

—First, revised the tax laws that provided incentives for companies to search for oil. In effect, taxes were raised, making less capital available for exploration efforts.

—Second, imposed price controls on the whole economy, then lifted them for everyone except the oil industry. The result has been that oil companies could not recover cost increases, except by submitting to the cumbersome machinery of a government regulatory agency.

—Third, maintained price controls on certain categories of natural gas, leading to natural gas shortages in some areas of the U.S., year after year.

—And on top of it all, some political leaders in the U.S. are now proposing to break up integrated oil companies—18 or 20 of our largest oil corporations, depending on the particular proposal. It's a political reflection of consumer anger and mistaken beliefs about the causes of higher prices.

Many consumers in this country believe the large oil companies—not the OPEC countries—imposed the higher prices of gasoline and fuel oil. Politicians have not troubled to set the public straight. The price of 60 cents for a gallon of gasoline in this country seems like a great bargain to our foreign visitors; but I can assure you that some of our politicians repeatedly cite higher prices as the principal reason why organizations should be cut down in size, without bothering to mention that OPEC and not the companies caused the prices to go up.

Needless to say, proposals such as these have only added to the general uncertainty of the investment climate.

Here in the United States, we are still searching for the policies that will help us reach our own energy goals. Essentially, what we need are policies that will encourage development of our domestic energy resources, balanced by efforts to conserve energy and protect our environment.

Just two weeks ago, the U.S. Energy Research and Development Administration announced that it would be giving highest priority to the conservation of energy—giving it a weight equal to *developing* energy. The American Petroleum Institute has long supported the concept of a "duel approach"—balancing development with making more efficient use of energy—so we heartily endorse this new emphasis by the government.

Turning to the question of environmental constraints, we find—as with financial limitations—that the impact of government is overwhelming.

Once again, I would like to cite the experience of the United States.

First let me say that the Institute and the petroleum industry have supported—and will continue to support—sound regulations that aim at improving the quality of the nation's air, water, land, and other natural resources. We are fully aware that such laws can provide substantial benefits to society.

We are equally aware, however, that unless regulations are intelligently drawn and sensibly administered, environmental rules can often lead to costly delays and wasted funds, and at times, to social and economic disruption. Often they are simply counterproductive.

The Alaskan pipeline is a case in point. As you may know, this is the largest engineering project ever undertaken by private industry. It involves building a pipeline to link the oil fields at Prudhoe Bay in the north to Valdez, a warm water port in southern Alaska—a distance of 800 miles.

This giant construction project was held up for well over three years because of environmental objections. Partially as a result of this delay and design changes, the estimated cost of the pipeline in 1969 of $900 million has soared in 1976 to about $7 billion—an increase of more than 700 percent. Moreover, Alaskan oil will not begin coming into West Coast ports until late 1977 at the earliest, years after it would have been available to us had construction gone ahead on schedule. Some doubt that the Arab oil embargo of 1973–74 would have had as serious an impact on the U.S. as it did had the Alaskan pipeline been allowed to proceed on its original schedule.

The environmental controls on the Alaskan pipeline were applied several years back. Their effects, however, are still very much with us—in terms not only of greatly increased costs, which must be passed through to consumers, but also of increased dependency on non-U.S. energy sources. But there are numerous other controls posing a threat to U.S. energy goals.

For example, our Congress is considering proposals to tighten further the present strict air quality requirements.

I will not spell out the details of these complex proposals, but I do want to mention some of the effects. Under the proposals, industrial expansion in some areas of our country would just about grind down to a halt.

Let me give one example. Suppose a company proposed to build a new factory. If it appeared that with this new factory the air quality of the area would be lowered below a certain level, the planned factory could not be built in that area. It would have to be located somewhere else, perhaps miles away. As a result, the factory might not be built at all. And as a further result, there would be fewer jobs and paychecks than there might have been.

The real question then is: How far should environmental restrictions go?

The petroleum industry alone spent more than $7 billion during the period 1966–1974 to meet environmental regulations. The cost trend is upward. If that trend continues, the industry's cost of complying with federal, state, and local pollution control regulations may amount to more than $20 billion by 1985. Worthy as these goals are, outlays of this size would surely take away from capital available for exploration and production.

A better balance of environmental goals and energy goals simply must be found.

As we take up the larger challenge of meeting the world's future energy needs, it becomes very obvious that success or failure is almost wholly in the hands of governments.

Unless some radical changes are made—unless the trend toward more government control is reversed—the laws of economy will count for very little. Instead, the rules and regulations of government—political constraints—will determine the outcome.

So far, management of energy problems by governments around the world is simply not working. Enormous hidden costs of inefficiency, abandoned exploration, and lost production are building up. I am deeply concerned that someday—like the people who borrow money constantly to pay old debts—it will all catch up with us in the form of a severe shortage and steeply higher prices.

At that point, we will surely have to pay a high price for ignoring that pressure cooker I mentioned earlier—the pent-up worldwide demand for more rewarding lives, a demand directly tied to energy.

A wise American—Henry Adams—said that "practical politics consists in ignoring facts." But the dimensions of the worldwide energy problem are too large to be left to politics. Somehow, we must get back to facing the facts before it is too late.

Discussion

Question: Mr. Ikard, I enjoyed your talk a great deal and I concur with everything you said. I would like to ask a few things. You have indicated an extreme urgency in finding energy, not only for us, but for the world. You have, I think, and this conference has indicated a lack of fossil fuel energy. You've indicated what we're doing in regard to other forms of usable energy which can go into electricity and perhaps hydrogen, as I feel is the way to go. Is the restraint that we have in getting on with a Manhattan-like emergency type of world-wide study of other types of energy, other than the fossil fuels, is it related to money, is it related to a restraint on where we want to put our money and energies, or is it a lack of use and having the best minds in our country to put on this project, and is there anyway that the world can get on with a Manhattan-like project to develop the other forms of energy that we're talking about?

Ikard: I think that when we speak of a Manhattan-like project, we're inclined to make the analogy that you did, to the development of basic atomic research. Where I have a problem with that approach is the fact that this is so much larger, in the sense of economic commitment, than the Manhattan project was. As I recall, the Manhattan project cost something like two to three billion dollars. Just the petroleum side of this will involve about 1.2 trillion over a 15-year period to 1985. The cost by developing other energy would be astronomical. As wealthy as the world is, I don't know that we're in a position to make that commitment. Also, any such world-wide project would be fraught with all kinds of political frustrations, many of which have become evident in this meeting here. While I don't quarrel with viewpoints that particular countries have, I think we're not being realistic if we don't recognize there are certain national views which supplant the collective view. That's the way human beings are, so I don't know that we can do a whole lot about it. As for the United States, it is disappointing that we have had a severe supply problem for some 7–10 years, and we have not yet been able to get the Federal government to focus on it. We need to establish the type of goals that we collectively, as a people, want to attain. This can only be done by reasonable, sensible public discussion. Once we establish those goals, then fitting the policies underneath is a relatively simple matter. We have a great technology in this country, and we can solve our problems if we give up this adversary approach. We need to recognize the fact that we have a very, very serious human problem, as I tried to point out. We're talking about the hopes and the aspirations and the fears of literally all the people around the world, and it's pretty parochial, pretty narrow-minded, simply to sit around and debate whether a company is too big or too small. We ought to get on with the basic problem.

Question: Is it a lack of brainpower or do you think we have the brainpower to get on with new types of energy or is this lacking?

Ikard: No, I think we have the brainpower to do that, I think we have the technology and the capability from a brainpower standpoint to do that. To bring on new energy sources, I think we need to establish some kind of order for their development. I think we're inclined to become enamored with the exotic new energy sources which may be 30 or 40 years away, and overlook the development of oil and gas which we've got to have till we get to that point. We need to develop goals, and then draw on our brainpower to reach them. We have a great deal of untapped technical capacity in this country.

Question: I would like to know if you have any active program in the oil industry to monitor and to audit, as it were, the energy used by your customers and to advise them in depth how they could save all unnecessary use and waste?

Ikard: As I understood the question, it is whether or not we have a program that would audit the use of energy and encourage the more efficient use of energy. Yes, we do, and the organization that I happen to be associated with has a very aggressive program in which we meet with users around the country and urge them to study their energy uses and see if they can use energy more efficiently. Some of the savings have been rather dramatic for most of the large energy users in this country. I am not suggesting that we're responsible for it, but the oil industry has been very active in this area and will continue to be.

Question: We've been associated with this oil patch for many years, we have watched the progress of the industry, we have watched their advancements in technology and some of the questions raised here are, do we have the know-how, which is quite evident. But there's one area in my experience which seems to be important today and we go right back to the American Petroleum Institute to get some of the answers, and that is information of the public, of the Institute, of what other technical societies are doing about this energy matter. Now, it would seem simple to put out a bulletin like this, for instance, on divestiture, but who gets it, how many of us get the report of the Chase National Bank, a very complete article on divestiture and its so-called hazard to the industry? So, my question is, in view of its vast experience, does the American Petroleum Institute today have a plan for getting the message to Garcia for getting it out to the public, so that the public will understand it and so they can vote appropriately?

Ikard: Yes sir, we do, and I notice an associate of mine taking your name down and I am sure you'll be receiving some of that information very soon. We think the more the public understands about this issue, the more people will understand that this industry and its integrated form works to the great benefit of the American consumer. Regardless of mistakes we've made, American consumers have the most secure supply of energy, at the cheapest cost, of consumers of any industrial nation in the world. Now, that to me should tell us something.

Question: Mr. Ikard said something about the brainpower available and untapped; probably he was referring to the brainpower here in the U.S. This morning we were talking about the lack of brainpower of countries in Latin America, for instance, that could contribute something to the lack of energy or to the decrease in energy production or decrease in petroleum. If something could be done to improve the brains, if I may say so, of people who are working in those kinds of jobs, in trying to find new sources of energy, that would definitely improve, not only our situation, but the situation also of other countries that could use the energy or petroleum or whatever, that we now are requiring for our own needs. I think that if the American Petroleum Institute, or some other institute, could do something in that respect, it would be greatly greatly appreciated by the people in the world who do need the energy since it rips them so much from their welfare.

Ikard: I agree with what you say. We happen to be a United States organization, but I am sure that we would be glad to participate in any kind of educational program or exchange. We do have an ongoing program of involving tours, instruction, and consultation with what we consider some of the best people in the industry dealing with technical matters. Primarily, of course, this activity is directed more towards the development and exploration of petroleum resources, but we do have that ongoing program in which many of the countries represented here are participating.

Kozmetsky: Thank you, Mr. Ikard. I imagine you would agree with me, that you might encourage those nations that don't have such a program to follow the lead of the Japanese who have probably been the most effective nation in establishing committees within their own country, which visit all parts of the world, which they do in a very short time, come back to their own country with the information, and disseminate it most effectively.

Ikard: We have a very happy and pleasant relationship with the Japanese, and it's been a relationship to our mutual advantage I hope. It certainly is to ours.

Question: I gather that it is not reasonable to go at this with a Manhattan-like project–that is, a government type of thing–but to go at it more from the university stand point and this is the plan. Then I would like to ask Dr. Woodson, does your department and the other departments of universities with the know-how have the money they need, or should we get on our soap boxes with our congressmen, etc., and tell them to give us more money so we can give more money to the universities? I feel this is a very urgent thing to get on with, something other than the oil and gas problem, although that's got to be thought of.

Ikard: I think one of the first things we have to do is to develop the freedom to do the thing you suggest, which is simply to make it possible for people in universities and the academic world and the business world and the government world to work together. It is presently the situation in this country that anyone who is any way connected with business cannot become associated with the Federal government in any sort of research activity. This to me is very shortsighted, and I think it has cost us the ability of many many dedicated, highly qualified scientists. Secondly, there probably is a need for more money. I am trying to suggest here that I think this is something we should talk about. We should establish what our goals are, then we should carefully design the programs we think should be, our best minds dictate, should be followed. Then we should fund them; if we can't fund them in the private or academic sector, then they should be funded by the government.

Kozmetsky: Thank you. I'd like to state that at our University and in the energy research center we've been coining the phrase "R&D Square." We believe in America—after our 2 1/2 decades of research and development which was done for aerospace—we have learned our lesson; we must do in parallel research, develop, and disseminate, and I think that's what Mr. Ikard was saying.

Ikard: That's exactly correct.

Kozmetsky: Those of you who are going to be visiting Friday might want to visit our geothermal research. I think it is one of the leading examples in our country of R&D Square.

Session II — National and Multinational Energy Perspectives

Overview Presentation

Dr. George Kozmetsky
Dean of the Graduate School of Business and College of Business Administration at The University of Texas at Austin

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Oil-Exporting Nations' Perspective

Sheikh Abdullah Tariki
Former Minister of Petroleum of Saudi Arabia

Discussion

Developed, Oil-Importing Nations/Eastern Perspective

Mr. Masami Ishida
President, Petroleum Association of Japan

Discussion

Developed, Oil-Importing Nations/Western Perspective

The Honorable Ronald Wm. Brown
Labour Member of Parliament, United Kingdom

Discussion

(continued)

Developing, Oil-Importing Nations' Perspective

The Honorable Abdul Majid Mufti
Economic Minister
Embassy of Pakistan, Washington, D.C.

Discussion

Energy Politics in Eastern Europe: Structural Changes in Production and Consumption and Resource Dependence

Dr. George W. Hoffman
Professor of Geography at The University of Texas at Austin

Discussion

Overview Presentation

Dr. George Kozmetsky
Dean of the Graduate School of Business and College of Business Administration at The University of Texas at Austin

It is my pleasure to welcome each of you to the second session of the International Ex-Students' Conference on Energy. Today it is our purpose to explore energy from a multinational perspective.

The energy dependence of all societies—industrial, developing, or even agricultural—is upon primary energy resources for heat, light, and power. While primary energy resources play a necessary and strategic role in promoting and sustaining economic progress on both a national and international scale, it is also clear that no nation can achieve its goals without the mobilization of a great many other resources—technological, human, and other natural resources.

Energy crisis to many is a recent phenomenon that can well extend into the 21st century. The quadrupling of oil prices by the OPEC nations in 1973 gave rise to speculation that the oil cartel would provide a mixed bag of unmanageable problems for most nations of the world. Among the questions that arose at that time were:

> Can the international monetary system absorb and adjust to a transfer of unprecedented wealth to the OPEC nations without extensive disruption because of the magnitude of the imbalance of international payments?
>
> Would the consuming nations be able to absorb the increased investments the oil-producing countries would make upon them?
>
> What will happen to worldwide currency values?
>
> What kinds of necessary intern[illegible]ustments by consuming countries will be ma[illegible] What effects

will these adjustments make on the internal economies? What will happen to their living standards? What will be the political consequences?

It is now 2½ years after OPEC quintupled prices. Most nations of the world have survived the increase in oil prices as well as in other materials. In this period, the world has seen that many of its problems have been put behind while others have arisen. The 1973 dire prediction of oil shortages has not happened. Oil-consuming nations are beginning to see that the oil producers have successfully exploited their monopoly. In turn, these nations have begun to seek out the Arabs, Iranians, and Venezuelans and to take them more seriously than ever before. Another consequence has been the focusing of many nations' attention to the problems of the poor countries of the world who do not have oil. The OPEC oil price increase has played a significant role in having the Communist countries of Eastern Europe more dependent on the USSR as their chief oil supplier. Finally, there has been a renewal of oil exploration within the geographical boundaries of individual nations' control, such as the United States as well as in other nations such as Great Britain, Norway, Denmark, Brazil, China, and Japan.

The current energy dilemma is more than an oil price increase. Nor is it simply a matter of cracking the walls of the OPEC cartel. They are nothing new. Adam Smith observed in 1776 that "people in the same trade seldom meet together, even for merriment, or diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices." History teaches us, also, that a cartel only works so long as demand is so insensitive to price that higher prices will increase the seller's total revenue.

Historical perspectives of energy in the world economy for our overview this morning will examine the more fundamental relationships between consumption and supply. Prior to 1900 most individual nations in the world were able to provide for their own energy requirements by utilizing their own national resources. For our purposes today, I wish to explore with you the trends and basic changes in energy supply and demands for two distinct time periods: *1925 to 1968* and *1973 to the present*.

During the period 1925 to 1968, all world regions had an absolute growth in energy consumption and espe-

TABLE 1
Energy Consumption by World Regions
(Percentage Distribution)

	1925	1950	1960	1968
North America	50.4	48.9	39.5	37.4
United States	48.3	46.0	36.9	34.5
Western Europe	34.8	22.4	20.2	19.7
USSR and Eastern Europe	5.4	17.8	22.3	22.7
USSR	1.7	11.6	15.3	16.3
Communist Asia	1.6	1.7	5.6	5.3
Latin America	1.7	2.5	3.7	3.9
Asia*	4.1	4.1	5.9	8.3
Japan	2.1	1.8	2.6	4.4
Africa	0.9	1.6	1.7	1.6
Oceania	1.1	1.1	1.1	1.1

* *Includes the Middle East*

TABLE 2
World Energy Consumption by Primary Sources

	1925	1950	1960	1968
Solid Fuel	82.9	61.0	47.6	36.7
Liquid Fuels	13.3	27.7	35.7	42.8
Natural Gas	3.2	9.7	14.6	18.3
Hydroelectricity	1.7	1.7	2.0	2.1

TABLE 3
World Energy Consumption by Source and Region, 1925 and 1968
(As Percentage of Each Area's Total Energy Consumption)

	Solid Fuel		Liquid Fuel		Natural Gas		Hydroelectric	
	1925	1968	1925	1968	1925	1968	1925	1968
North America	74.5	21.9	18.9	43.6	6.0	32.6	0.6	1.9
United States	74.2	22.6	19.2	43.0	6.2	33.0	0.5	1.3
Western Europe	96.0	37.3	3.2	54.3	—	4.7	0.7	3.5
USSR & Eastern Europe	82.9	53.1	15.2	27.9	1.7	18.0	0.1	1.0
USSR	64.9	43.1	34.2	33.0	0.7	22.6	0.1	1.3
Communist Asia	94.0	91.9	6.0	7.2	—	—	—	0.9
Latin America	37.6	6.5	56.6	70.6	4.2	19.2	1.6	3.7
*Asia	83.1	30.5	14.4	62.1	0.8	4.6	1.7	2.9
Japan	92.4	27.9	4.4	67.1	0.1	1.2	3.1	3.6
Africa	91.6	54.9	8.3	41.2	—	2.0	0.1	2.0
Oceania	92.6	48.6	6.9	48.6	—	—	0.5	2.8

* *Includes Middle East, Other Asia, and Japan*

cially after the post-World War II years. (See Table 1.) Relative energy consumption growth fell in North America and Western Europe. The increases were in the U.S.S.R. and Eastern Europe, Communist Asia, Latin America, Asia, and Africa.

In the 1925–1968 time span there has been an interfuel consumption shift from solid fuels to liquid fuels as the world's primary source of energy. (See Table 2.)

The consumption interfuel shifts have been primarily after World War II. Thus where solid fuels were predominant in 1925, liquid fuels became predominant in 1968. Incrementally liquid fuels accounted for over half the expansion in worldwide energy consumption over the 1925–1968 period. Natural gas grew faster than liquid fuels. Hydroelectric consumption rose as fast as oil over the 44-year period, but it is a minor factor in a global context.

In general, each regional relative consumption of energy has paralleled the shifts for the world; only the quantitative shifts varied. A comparison of the world consumption by energy source and region for the period 1925 and 1968 is shown on Table 3. Over 50% of the energy consumption in the U.S.S.R. and Communist Eastern Europe was dependent on solid fuel. So was Communist Asia and Africa. The United States' consumption has become more dependent on liquid fuels and natural gas. Solid fuel as an energy consumption source in 1968 was 23%. It was less than 20% in 1920, and most forecasts continue to show solid fuel to be below 20% in the 1985–1990 time period. Coal reserves in the United States account for 90% of all known fossil fuel resources. While the U.S. relative dependence on coal for energy consumption will remain stable, new sources will be required from Western coal

TABLE 4
Ratio of Production to Consumption by Major Regions, 1925 and 1967

	1925	1967
North America	1.04	0.95
United States	1.07	0.95
Western Europe	1.03	0.46
USSR & Eastern Europe	1.15	1.08
USSR	1.07	1.14
Communist Asia	0.95	1.00
Latin America	1.62	2.01
Asia	1.18	2.05
Middle East	3.32	11.24
Japan	1.08	0.24
Africa	0.98	10.00
Oceania	1.03	0.69

in order to meet environmental regulations. It also looks as if the United States will export less low-sulfur coal.

The declining world role of coal and the growing importance of petroleum has been accompanied by dramatic changes within the geographical distribution of world energy output and in regional energy supply-demand balances. A ratio of production to consumption is one way to determine relative regional self-sufficiency. Table 4 shows such ratios for 1925 and 1967. In 1925 all regions showed general self-sufficiency except for Communist Asia and Africa. By 1967 Western Europe especially had great dependency upon other regions. Japan in turn had great dependency upon the Middle East. Meanwhile Africa as a region and the Middle East have attained an order of magnitude of independence.

Thus by 1976 regional self-sufficiency persisted only in Asia, Africa, and the Communist regions. Elsewhere we see marked regional imbalances notably in Western Europe and Japan. While the United States has only a modest imbalance in the table, by 1976 it is estimated that imports will supply 41% of U.S. petroleum demands.

World energy trade has risen by more than 5½ to 6% annually since 1920. In addition, it also shifted dramatically from intraregional to interregional trade. World energy trade has thus grown faster than the aggregate dollar value of all world trade. In 1929 world energy trade was 6%; by 1967 it was 10%; and in 1975 it was estimated to be 15%.

Now let us examine briefly the estimated reserve of various worldwide primary sources of energy (Table 5).

Reserve data are tenuous at best. We still have not truly inventoried our global resources, nor are we yet capable of providing a scientifically valid reserve estimate. The largest relative estimated reserve for coal is in the U.S.S.R.; the relative estimated reserve for oil is in the Middle East; and the largest relative natural gas reserve as well as uranium is in the United States.

The U.S. Geological Survey "reckons that much of the 26.1 million square miles of the world's petroleum-prospective area remains untouched. For example, the U.S. accounts for about 10% of the world's prospective oil-bearing area, but it has a drilling density of about seven times greater than the average for all the countries in the world." Dr. Grossling has assembled data on 10 regions—Australia and New Zealand, Japan, Canada, Western Europe, U.S.S.R., U.S., Middle East, China, South and Southeast Asia, Africa, and Latin America. He estimates the size of each area (including offshore regions up to 200 meters deep) and estimates the number of wells drilled into each area. These data show that drilling has concentrated on a limited part of the world.

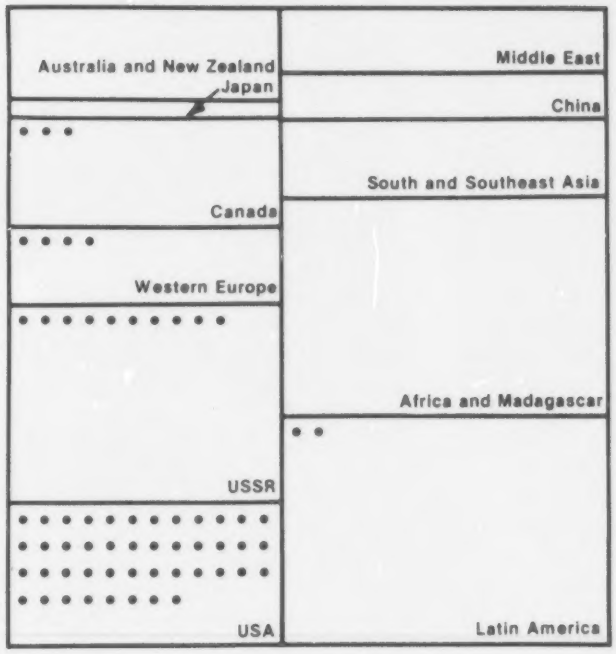
Figure 1 drawn up from Grossling's data compares the sizes of the prospective oil-bearing areas, and the amount of drilling activity that has been seen in each area. According to Grossling, "the chart is an attempt to clarify and simplify the global oil-potential situation which has been a difficult picture to visualize—even for the expert—let alone for the planners, policy makers, and the general public." The chart shows "that Latin America alone has about four times more prospective oil-bearing area than the oil-rich Middle East."

TABLE 5
Estimated Selected World Energy Resources
Percentage by Regions—1967

	Coal	Oil	Natural Gas	Nuclear
North America	18.1	10.1	25.6	65.8
United States	16.5	8.0	22.1	44.8
Western Europe	6.5	0.6	10.6	5.6
USSR & Eastern Europe	68.5	12.1	25.7	1.0*
USSR	68.5	9.2	21.8	N/A
Oceania	0.6	—	—	8.4
Latin America	0.2	6.4	4.8	1.4
Asia	5.2	—	—	—
Middle East	—	58.5	16.8	—
Africa	0.8	9.4	12.6	17.5

** Uranium resource figure given for Yugoslavia; no other data were available for USSR and other Eastern European regions.*

FIGURE 1
Where World's Drilling Potential Lies



each dot represents 50,000 wells drilled

source: U.S. Department of Interior

Grossling says "it may also be surprising to see that both regions have very little actual drilling in comparison to their potentially favorable areas."

Grossling warns that "the volume of oil in a given region is not necessarily proportional to the size of the favorable area, nor is the number of wells drilled a direct indication of the amount of oil that has been or will be found. Both points are well illustrated in the Middle East where a relatively small amount of drilling has developed large amounts of oil. But this comparison of favorable areas and the number of wells drilled is an indication of the extent to which prospective targets have been tested."

The figure shows that China has a surprisingly small prospective oil-bearing area—only Japan's is smaller. Latin America and Africa appear to be the most significant areas yet to be exploited to any extent. In Latin America there is a prospective area which is about 1.6 times larger than that of the United States, which has seen some 20 times as much drilling.

Now let us briefly review other primary energy resource potentials especially for the United States.

Nuclear Power

Nuclear power was seen in the Sixties as the key to the United States' energy future. That hope still exists, but the arrival of nuclear energy to the market place has been delayed. Construction costs of facilities have been underestimated. Nor have industry and the U.S. government foreseen the opposition that construction of such plants would generate from conservationist groups.

Nuclear power in the U.S. is gradually increasing its share of the energy market. In 1970, it provided less than 1% of the country's total energy, but by 1985 it is expected to contribute 14%.

Shale Oil

Shale oil, because of economics and technology, is expected to be the first liquid synthetic fuel produced in the U.S. The major area of oil shale reserve is located in our Western states, estimated to contain almost 80 billion barrels of recoverable oil. By 1976 almost all shale development has been slowed down in North America. It is still not clear when we can depend upon it as a supply source.

Tar Sands

There are no significant tar sands deposits in the United States. The Athabasca Tar Sands in Canada, however, contain large quantities of potentially recoverable oil. Although necessary technology exists, economics currently make oil from tar sands generally unattractive. Tar sands like shale oil are in a state of limbo.

Many forecasts of world energy supply demands exist. There is no reason to select one over another for today's discussion as this is not within the scope of our session. Therefore we can get to the questions to be answered in subsequent presentations. The issues-questions we are concerned with in this session can be categorized about (1) the OPEC Cartel, (2) Middle East and Worldwide Politics, (3) the International Monetary System, (4) Impact on Developing Oil-Importing Nations, (5)Worldwide Environmental Problems, (6) International Trade and Balance of Payments, and (7) National Self-Sufficiency.

(1) The OPEC Cartel

The sparsely populated lands around the Persian Gulf contain well over half of the world's proven oil reserves. In 1973, the oil-rich nations of that region asked for and got a fourfold increase in crude oil prices. Today it is more than ninefold. "The era of cheap oil for the industrialized world is finished," said the Shah of Iran. Question: When and how will oil prices be stabilized?

In times past, a handful of American and European petroleum companies with far-flung international operations dominated the world oil market. Now, however, a cartel of major oil-exporting countries—led by the Persian Gulf states—is doing the dominating. What are the OPEC nations' views toward the American Congress' examination of divestiture of our major oil companies? What are their plans for reverse divestiture, if any? How will the major oil producers distribute their products? Through the major oil companies? Their own refinery and marketing organizations? How far upstream will the major products go in terms of final products?

(2) Middle East and World Politics

It is important to note that the political problems associated with importing oil differ markedly, depending upon the country or region where the oil originates. The threat of a nation cutting off oil to the United States or other industrial importing nations in order to gain political leverage is much more remote, for instance, when the oil is coming from South America rather than the Persian Gulf. Even within the Persian Gulf region, political distinctions must be made between, for instance, non-Arab Iran and Arab Kuwait. Political threats to Western Europe are not the same as for the U.S. or Japan.

Formerly, political power was based on military power which was based on technological and industrial power. Formerly, colonial agreements controlled trade of certain raw materials, allowing consumers to control prices. Now the producers control the oil price by controlling production. The market changed from a buyer's to a seller's market, and industrial nations' heavy dependence on oil aggravated the situation when collaboration among producers produced an embargo. It is not the monopoly over the supply but the monopoly over price. Now the issue is: how is the power of monopoly over price to be used as a political weapon?

(3) The International Monetary System

Soaring prices for so essential a commodity as oil have strained an already unstable international monetary system. Periodic international monetary crises since 1960 have caused major trading nations of the world to abandon most of the fixed exchange rates and to float their currencies. While the floated currency has worked out better than many anticipated, it is vulnerable to the sudden dislocation threatened by increased oil prices. How much of this responsibility should be shared between the OPEC oil-exporting nations and the 18 oil-importing nations?

(4) Impact on Developing Oil-Importing Countries

The more than 900% increase in oil prices dealt the developing countries a far more economic impact than it did America, Europe, or Japan.

The developing countries were impacted first by the food prices and then by the crisis in oil prices. For the short term, the lives of millions depend on explicit and rapid policy actions to provide aid in one form or another from the oil-exporting nations and the rich industrialized nations, as well as from the international organizations which they support. How will priorities for the OPEC nations be established for aid to underdeveloped nations? Will it be by each OPEC nation? As a cartel? Will aid emphasis be placed primarily on Arab and Moslem developing nations? If so, when and how will financial aid be provided for the international annual deficit of $42 billion for the developing nations?

(5) Worldwide Environmental Problems

Many energy-associated environmental problems are global in nature and must be solved in concert with other nations or not at all. The safeguarding of nuclear material is an excellent example. Another instance is oil pollution of the oceans. Air pollution is a global problem.

(6) International Trade and Balance of Payments

A return to the situation before the 1973 Arab-Israel war—that is, of rapidly growing U.S. oil imports from the Middle East—would put this country in direct competition with the other oil-importing nations. This raises serious questions, not the least of which are: Will the Middle East nations increase their growth in production? What would be the impact on U.S. balance of payments, and on the economies of Europe, Japan, the Third World; and, how would U.S. relations with them be affected?

In addition, growing imports would require significant stockpiles of oil, either in the form of stored oil or developed but non-producing wells, as insurance against interruptions. This is a very costly business. The only thing more costly would be not doing it.

(7) National or Regional Self-Sufficiency

A program of energy self-sufficiency on a national or regional basis raises a whole different set of questions. Can North America develop its resources at a greatly accelerated pace without doing irrevocable damage to the world's health and environment? Will the United States, going it alone in energy, encourage Japan and Western European nations to make bilateral agreements with the producing nations? How would this affect non-rich nations?

The most immediate and real problems for more people in this world are the shortages of fuel, fertilizers, and food in Africa, South Asia, and parts of Latin America. Imaginative and generous forms of multilateral assistance to these people from the industrialized nations and oil exporters are needed.

This second session of the Conference is concerned with National and Multinational Energy Perspectives. During the course of today's sessions, we will explore these questions and other dominant features from

1. Oil-Exporting Nations' Perspectives
2. Developed, Oil-Importing Nations/Eastern Perspective
3. Developed, Oil-Importing Nations/Western Perspective
4. Developing, Oil-Importing Nations' Perspective
5. Planned Economy Nations' Perspective

Oil-Exporting Nations' Perspective

Sheikh Abdullah Tariki
Former Minister of Petroleum of Saudi Arabia

All the oil-producing and exporting countries, known as OPEC, are developing countries. In most of these states, oil provides the largest portion of the national income. The oil production in OPEC amounts to 27,975,000 bbl/day or 51.5% of the world production. The refining capacity of OPEC is 4,376, 115 bbl/day or 7.31% of the world refining capacity. The oil reserves of OPEC are estimated at 466 billion barrels or 65.6% of the world known reserves.

Table Number 1 indicates the population, the per-capita income, the oil reserve, production, and oil refining capacity for each country. The data presented in this table show clearly that OPEC belongs to the developing countries which are commonly referred to as the Third World, with the exception of the small countries on the Arabian Gulf and Libya, where the per-capita income is high because of their small populations.

Relations Between OPEC Governments and the International Companies

The activities of the international companies in the Arabian Gulf Region started in 1902 in Iran. The oil was discovered in 1907 by William Knox D'Arcy (Australian-British citizen), and the Anglo Persian Oil Co. was formed. The conditions of this agreement were the basis for the subsequent agreements concluded in the twenties and thirties between the international companies and Iraq and the Emirates of the Arabian Gulf.

TABLE 1

Country	Oil Production 1000 b/d	% To World Total	Refining Capacity b/d	% To World Total	Proved Oil Reserves Billion Barrels Jan. 1, 75	% To World Total	Population	Per Capita G.N.P. ($)
Algeria	1,500	2.7	122,400	0.21	7.700	1.08	15,770,000	500
Iraq	2,400	4.4	168,500	0.28	35.000	4.92	10,410,000	640
Kuwait	1,950	3.6	684,800	1.1	72.800	10.24	880,000	8,450
Libya	1,400	2.5	76,400	0.13	26.600	3.74	2.257,037	2,980
Qatar	410	0.76	7,400	0.01	6.000	0.84	115,000	5,940
Saudi Arabia	7,000	13	537,200	0.9	164.500	23.14	8,100,000	1,300
United Arab Emirates	1,800	3.3	—	—	32.420	4.56	210,000	6,700
Iran	5,600	10.4	780,000	1.3	66.000	9.28	32,001,000	760
Equador	165	0.31	43,900	0.07	2.500	0.35	6,598,300	370
Indonesia	1,300	2.4	427,700	0.7	15.000	2.11	124,600,000	120
Nigeria	1,850	3.4	57,000	0.09	20.000	2.81	79,758,969	250
Venezuela	2,400	4.4	1,450,815	2.4	15.000	2.11	10,970,000	1,360
Gabon	200	0.37	20,000	0.034	1.750	0.25	520,000	1,250
TOTAL	**27,975**	**51.5**	**4,376,115**	**7.31**	**466.170**	**65.43**	**292,190,306**	

Total World Production 53,850.6 b/d

Total World Refining 59,396,894

OPEC % Reserves To World Total = 65.58

In those agreements, the companies were exempted from any income tax except for the land's royalty which amounted to 12.5% of the declared FOB oil prices. The land in the Middle Eastern Countries is owned by the governments. This continued until 1950. During this period, the governments netted 21 cents/bbl while the companies netted $1.88/bbl as shown in Table 2.

At the end of 1950, the parent companies of ARAMCO agreed to pay 50% of the net profit as income tax, retroactive from January 1950. But ARAMCO and the other companies who followed suit interpreted this percentage to include the land royalty of 12.5%. In addition, they allowed for themselves deductions amounting to 18% of the FOB prices. This, of course, made the governments' share to be much less

than the companies', as indicated in Table 2. This condition led the governments to refuse these deductions which were imposed by the operating companies.

During the fifties, the parent companies of the operating ones insisted on posting the oil prices and refused to ever consult with the governments owning the crude oil in this regard. In addition, the companies decided the oil production rates in each country. Sometimes these rates were either increased or decreased for political reasons dictated by the governments of the countries of the parent companies without much consideration for the demand and supply pattern. This meant that any oil-producing country which did not follow the European or American political camp faced oil production cuts and consequently less income which affected its economy.

This condition continued through the fifties. During this period, OPEC tried unsuccessfully to convince the companies for the need of cooperation and that prior consultation was needed before increasing or decreasing the oil prices. This was essential for the different countries to help them plan their budgets on solid foundations. On many occasions, the parent companies surprised the oil-producing countries by lowering the prices without any justification which caused financial problems for these countries.

In 1959, OPEC representatives met in Cairo during the First Arab Petroleum Conference and decided to promptly meet in case the oil prices were lowered in the future by the companies without prior consultation with the governments. The oil companies ignored this warning and lowered the prices in August 1960. This caused OPEC representatives to meet in Baghdad in September 1960 and to establish the organization which is presently known as "OPEC."

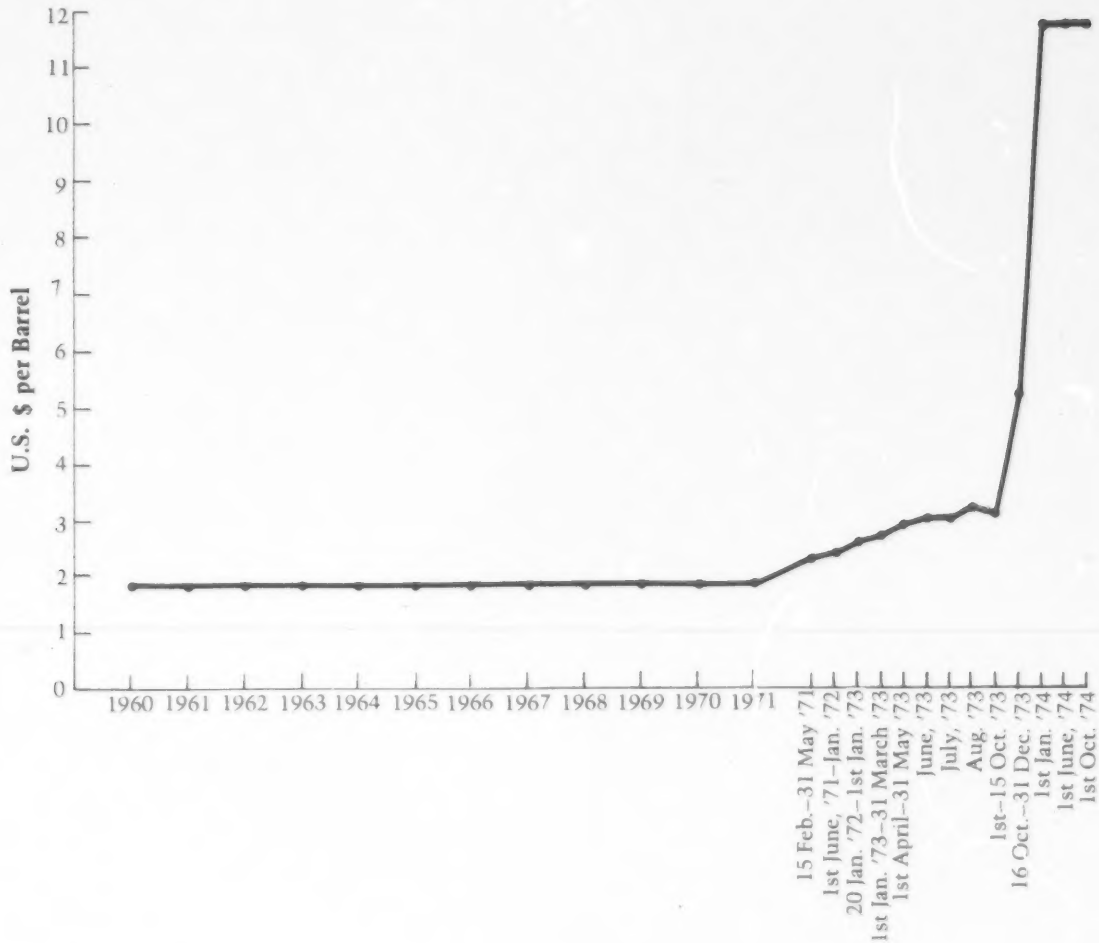
The first decision of the organization was to restore the previous oil price. The companies refused to comply but did not dare to reduce the prices any more. This condition of price freeze lasted through June 1971.

During this long period, OPEC tried very seriously to achieve some understanding with the international companies and to formulate new bases for cooperation. These bases were to include guarantees for the companies to acquire oil at reasonable prices and also to give the countries who owned the oil the right to control their natural resources and to obtain

TABLE 2
Evolution of Oil Revenues in the Producing Countries and Net Income of Foreign Oil Companies for the Period 1913–1975

Year	Producing Country's Income, $ per Barrel	Companies' Net Income, $ per Barrel
1913–1947	0.21	1.88
1948	0.34	1.52
1949	0.31	1.14
1950	0.37	1.20
1951	0.41	1.27
1952	0.53	1.11
1953	0.66	1.09
1954	0.72	1.08
1955	0.76	0.97
1956	0.78	0.97
1957	0.80	0.98
1958	0.79	1.05
1959	0.79	0.88
1960–1965	0.82	0.88
1966–1967	0.85	0.85
1968–1969	0.88	0.82
1970	0.91	0.79
1971	1.26	0.82
1972	1.44	0.93
1973	1.94	1.25
1974	7.73	1.49
1975 (Jan)	10.08	0.47

FIGURE 1
Evolution of Prices per Barrel



maximum advantage from these resources. The foreign companies ignored these demands and in fact refused to even acknowledge that OPEC did represent the oil-producing countries.

All in all, even though circumstances changed in the region and in the world, the international oil companies refused to change and insisted on their right to fix the oil prices and to fix the production rates in each country. The oil prices remained frozen for 11 years while prices of goods imported by OPEC continued to increase at an annual rate of at least 8%.

This persistent attitude of the giant international oil companies, commonly referred to as the "seven sisters," forced the governments to act firmly. The turning point came after the Libyan Revolution in September 1969. The Libyan government, then with ex-

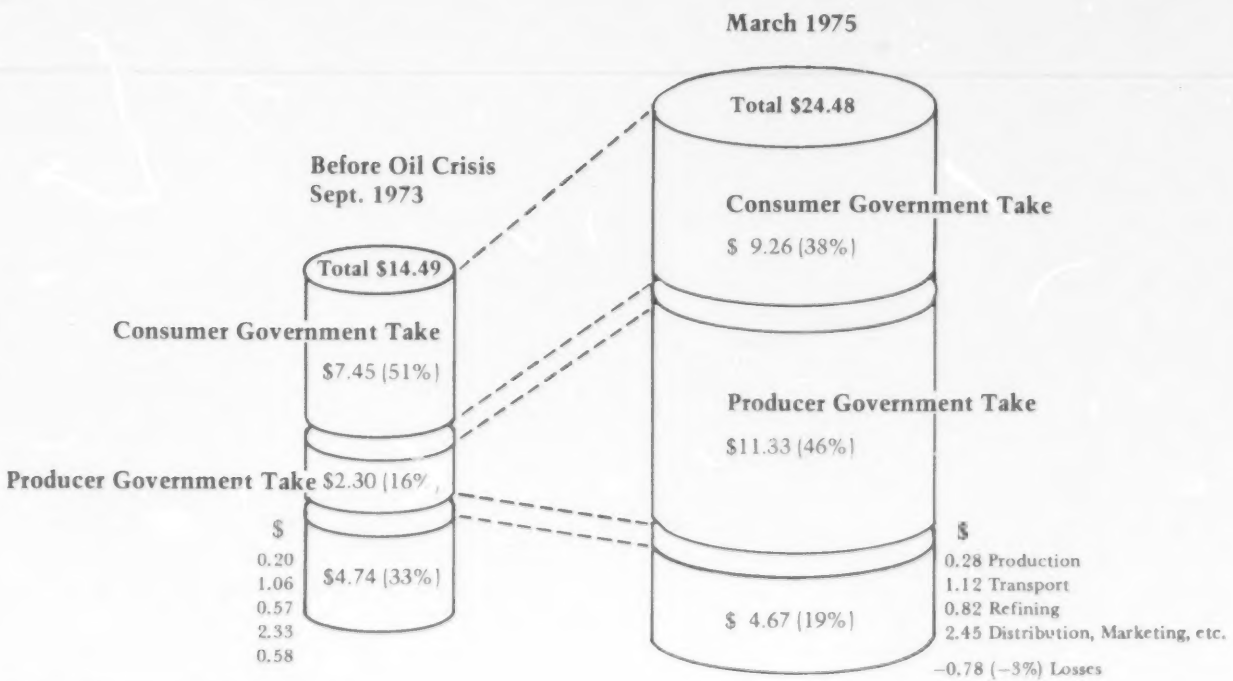
cess monetary reserves, ordered the companies either to comply with the government regulation or to stop oil production. The companies were then forced to agree to comply with the government orders and regulations and to raise the prices of the exported oil. This of course encouraged and opened the doors for the other governments to follow suit. On October 1, 1973 the price of oil was raised from $3.1/bbl to $11.2/bbl (Figure 1).

OPEC explained that the new prices matched the cost of energy production from other sources such as nuclear, coal, tar sand, and oil shale. The new price should be the value which would have been naturally reached if the freeze had not been imposed during the previous 11 years.

The new price resulted in sharing the benefits of producing, transporting, refining, and consuming the oil between the producing and consuming countries. For example, in September 1973 one barrel of oil sold in Western Europe at $14.49. From this amount the producing country collected $2.30 or 16% while the government of the consuming country took $7.45 or 51%. After 1973 the value of the products from one barrel of crude oil was raised to $11.33 (46%) and that of the consuming country was raised to $9.26 or (38%).

In reality, equality of sharing the profits between the producing and consuming countries was only achieved in 1974, and not in 1950. In the fifties, the oil companies were netting twice as much as the producing countries as indicated in Table 2 and Figure 2.

FIGURE 2
Breakdown of the value of petroleum products derived from one barrel of crude oil sold in Western Europe



Source: The Economist April 26/1975

OPEC—Is It a Cartel or an Attempt to Protect and Regain the Usurped Rights?

As indicated previously, the oil companies had full control of production rates, pricing, and exporting the oil. The producing countries were not even consulted on these matters. In essence, the oil companies acted as a commerce department for foreign trade in the producing countries. These countries started to demand improvement of the conditions such as to consider the land royalty as part of the general expenses as is the case in the U.S. and not as a part of the income tax.

The oil companies ignored these demands and insisted to operate under the conditions which were set in the thirties. In addition, they refused to change the income tax conditions of 1950 and 1951. This was due to the fact that the local governments were ignorant and weak during those days. After the fifties, these governments got together and formed a collective organization to protect their rights which was called "OPEC."

It took OPEC ten years to forcefully confront the oil companies in an attempt to achieve their goals to control their natural resources. Finally, after this confrontation became very strong between the Arab oil-producing countries and the Western countries headed by the Americans, the main supporter of Israel, the prices were quadrupled, and an oil payout was enforced against those countries which supported Israel such as U.S.A. and Holland. Figure 1 indicates the various development of oil prices since 1960.

What Happened to the Oil Money Which the West Paid?

When the oil prices were suddenly increased on December 31, 1973, Western Europe and the U.S.A. declared that the intention of the Arab was to ruin the Western economy and thus the Western civilization. This is far from the truth. All that OPEC did was to equalize the energy production cost by using the different possible sources, to unfreeze the oil prices which lasted over 10 years, and to evenly share in the benefits with the consuming countries as indicated in Figure 2.

It became apparent that OPEC had no concrete plans to develop their other natural resources. This of course resulted in channeling the excess petro-dollars back to the banks in Western Europe and the USA, and to the World Bank as shown in Table 3. In addition, OPEC started assistance programs to the poor countries.

TABLE 3
Flows of OPEC Surplus Funds

Investments in:	Jan–June 1975 Amount* $ Billion	Jan–June 1975 Percent Share	1974 Amount* $ Billion	1974 Percent Share
Eurocurrency Market	10.0	43	22.5	37.5
United States	2.0	9	11.25	19.0
Britain	.7	3	7.5	12.5
Other Developed Countries	2.5	11	5.5	9.0
Less Developed Countries (including grants)	3.5	15	4.0	6.5
IMF oil facility and IBRD bonds	1.75	8	3.5	6.0
All other	2.5	11	5.75	9.5
Total	**22.95**	**100**	**60.0**	**100.0**

* *Estimates* *Source: U.S. Treasury Department*

After less than two years, it became evident that the increase in oil prices did not really endanger the capitalistic economic system. The increase was compensated by similar increases in the prices of exported goods.

Only the poor developing countries were seriously affected by the increase of oil prices as the balance of payments was disturbed. The assistance from both OPEC and the industrialized countries compensated somewhat for this effect.

It is my belief that OPEC can increase its assistance to the poor countries by selling the oil at prices lower than the prices paid by industrialized countries. The oil

TABLE 4
How Petro-dollar Surplus Grows

	Revenues 1974E $ Billion	Internal Use $ Billion	Surplus Funds $ Billion
Middle East			
Saudi Arabia	27.5	6.6	20.9
Iran	21.5	11.2	10.3
Kuwait	8.8	2.6	6.2
Iraq	6.9	4.8	2.1
Abu Dhabi	5.7	1.0	4.7
Other	2.7	1.0	1.7
Total	**73.1**	**27.2**	**45.9**
Africa			
Nigeria	8.9	6.9	2.0
Libya	9.0	4.0	5.0
Algeria	4.7	4.7	
Total	**22.6**	**15.6**	**7.0**
Venezuela	9.9	5.6	4.3
Indonesia	4.4	4.4	
Ecuador	0.7	0.7	
Total	**110.7**	**53.5**	**57.2**

consumption in these countries is relatively small and, therefore, the loss from the lower prices will not be great.

As we can see from the Table 3 and Table 4, the industrialized countries benefited from the increase of the oil revenues in the producing countries as most of the excess petro-dollars were deposited in their banks and were employed in their countries.

A good portion of the increase in the oil revenue was loaned to the poor countries at favourable conditions or as gifts.

What About the Future?

Experience in the past teaches us that strong ties based on mutual interests must be established between all countries. OPEC is in need of the co-operation of the industrialized countries to develop their other natural resources, and the developed countries need OPEC oil, especially the U.S.A.

The oil revenues have not so far been successfully employed in the producing countries, possibly for lack of good planning. It is, therefore, essential that the industrialized countries should provide the practical and technical assistance to OPEC to develop the existing natural resources. This will establish the good foundations for these countries to survive in the post-oil era.

The following are some suggestions where co-operation could be established:

1. Development of Agriculture in OPEC Countries
This will help achieve self-sufficiencies in food products and possible exporting to various other needy countries.

2. Development of Refining
This will increase the refining capacity and create new avenues for employment. In addition, the value of the products will be increased.

3. Development of Petrochemical Industries
The petrochemical industries should be planned and developed so that they will complement rather than compete with the presently existing petrochemical industries.

4. Optimum utilization of the associated natural gas to produce different kinds of fertilizers to be sold to developing countries at reasonable prices. These prices should not exceed the cost of gathering the gas, producing the fertilizers, plus percentage of profit, that equals to the banks' interest in West Europe and the U.S.A.

5. Sincere co-operation between oil producers and consumers to achieve suitable and economical resources for energy production, so that petroleum products could be reserved as the main source for petrochemical raw materials and food for animals and man.

Discussion

Question: I admire our speaker's generosity. I would appreciate knowing what value that he assigns to the American companies and technology for the exploration and development for the oil industry in the Middle East?

Tariki: I think we were more generous with the oil companies than some of the soldiers that became great oil companies because they worked in our country. Everybody knows that they were getting $1.00 and we were getting 10¢. In the Middle East the oil produced more than 20,000 bbl/day in certain countries like Saudi Arabia, and Qatar; the oil companies made billions of dollars from our country—Exxon, Texaco, Mobil Oil—they became riche: knowing the decision of ARAMCO. But I want to make it clear here that I think the oil companies are very essential to the development of the oil industry in the Middle East.

In the past they were the bosses and now they are becoming the employees. If they are to be good employees they will really benefit working with our government.

Question: I admire greatly Mr. Tariki's plan for agriculture development on a worldwide scale. I don't think it's new, though, and I think it's very obvious. Who, as you see it, is standing in the way of this plan being implemented? Who is blocking this plan from being put into action?

Tariki: You know who when you read about the noises coming in the press and the threat from certain officials in the U.S. or Europe about the prices, about the money that we are collecting. OPEC, you know, has a lot of small countries in the gulf area. Some in the gulf area were scared by this threat. When they started they were investing for a short term, and after that they changed their attitude. You know very well that these governments are so small that they really cannot scientifically make a government or a nation by themselves. Remember that one of these nations—a very tiny small one—went to be a member of the United Nations. It was admitted the same day with China of 800 million, and this country with only 27,000 people was admitted and treated equally with China.

You cannot understand our situation. We have artificial small countries there, and I tell you that every small one has an Ambassador from the U.S. and Great Britain.

Question: For the benefit of Sheikh Tariki in case he was not here yesterday, I was concerned with the tanker that has sunk off Colombia with 300,000 barrels in territorial waters. Secretary Parsky suggested that the U.S. would be willing to help that if the Ambassador of Colombia in Washington asked the U.S. government.

Well, I talked to the Ambassador this morning and in effect they have contacted the U.S. government, and they are proceeding to care of this situation. I was not aware of this when I left Colombia three weeks ago. But I wanted to suggest to Sheikh Tariki and other members of the OPEC countries that we could profit from this experience that has happened to Colombia, and maybe OPEC should consider an international organization like I was suggesting yesterday, because this is a small incident that fortunately is being resolved, apparently satisfactorily. But there are tankers transporting millions of barrels, this was only a small tanker carrying 300,000 barrels a day, but there are tankers today carrying 2 to 2 1/2 million barrels. I would like to suggest to OPEC through you, Sheikh Tariki, if something like this shouldn't be considered for future planning?

Tariki: If I understand you right, you want OPEC to help in this venture a country like yours, they need the know-how, and OPEC is now getting rich and they have their researchers. They could develop departments to help nations to develop their natural resources, oil resources, and maybe they will be members of OPEC, when they reach the level to be accepted as OPEC members.

Question: I think my question has been misunderstood.

I would like to suggest an administration be set up not only to handle this particular case of the tanker that sank in Colombia, but it could happen anywhere in the world, so that when something like this happens they would be able to move into situations like this, and we wouldn't have to wait 2 1/2 months as in this case we waited for the Colombian government to find a solution, because they hadn't had this experience before.

I think that the world could profit from this experience, and I

think it would be a wonderful idea for OPEC to carry out with regard to future accidents that could happen. Anyway, that's just a suggestion for you to discuss with the other members of OPEC, if you think it's worth it.

Tariki: I think better that you and I meet to discuss it, and I will convey your opinions and ideas to OPEC.

Question: I wish to say first that we worked together in Cairo and several other places, so I enjoyed hearing the story straight from the horse's mouth. I have one question. There are two sides to this situation, we are trying to come to Sheikh Abdullah terms; in other words, we are a producing country, we would like to cooperate. The question that comes to people's mind is, are OPEC countries stupid or are they really sympathetic to the consumers and that's why and is part of the fact that even though we cannot fully use the oil revenues, we still keep producing a lot of oil. I believe you tried to explain that, but I wante i to put it up to you as sort of a question, because it might seem to people listening to both sides that it is sort of a cat and mouse game being played. Now the question is, who's the cat and who's the mouse?

The question is, the dollar currency is deteriorating year in and year out, what do we do about it? I agree with Sheikh Abdullah that we should try to help developing nations, because that's one of our main concerns and nobody's doing very much about that either on a worldwide basis, and it's part of all this high talk you listen to around. What should we do then in a situation like this? Ask from the buyers to pay in our own currency, that's one possibility. Another possibility: instead of the dollar, let's take the special drawing rights which is sort of a big bag with several currencies, about 16 of them, of which the dollar is still the main currency. All the weight within the OPEC, let's sit down and figure out one currency which we might call the OPEC currency and then charge with that currency [illegible] our oil.

Tariki: OPEC is not that strong or that big to dominate the world monetary system or change the existing system. We don't want to do that, and as we said from the beginning, we want to cooperate. The Western nations need our energy and we need their know-how. And we are going to forget all the exploitation of our natural resources in the past and cooperate, knowing that we cannot do what we do without their cooperation. I mean that's fair to say that there is a world system of money, there is the dollar which is the strongest currency around, there is behind it all that the U.S. represents in the world. If the world chooses the dollar to be the sterling, the gold will go with that, we don't want to mix. I wish that the Japanese in front will allow me to say we want to use the Japanese method of meeting them at their own terms. Don't lose your aims, learn from them, and go and do it in your country and come and be a country. We want to cooperate, not for our sake or their sake, but for the sake of humanity. Suppose that we burn the oil by the end of the century, and we fail to have another source to take the place of the oil for cars and for petrochemicals and for paving the roads and making the synthetic fibers, what will happen to the waste? We really want to cooperate without exploitation; we want them to cooperate with an open mind and we have an open mind. We want not to meet as producer and consumer of one item; we want the whole world to meet. That's why we insisted on having all the developing nations meet in the conference discussing the economic order of the world. I don't agree to change. I will leave it that way, but I want to guarantee their cordial cooperation.

Question: I am pleased to be here to listen from that point of view which I detect may be somewhat under-represented on the program.

I was very interested in Sheikh Tariki's opening remarks about who is the cartel, whether OPEC is the cartel or are the major oil companies the cartel. We have heard both yesterday and today from directors of two of the major oil companies, Gulf and Texaco, and head of the major industry lobbying group, the American Petroleum Institute. I think that we consumers in the U.S. can identify with much of what Sheikh Tariki has said, because just as they felt the OPEC countries were not sufficiently involved in the development of world energy policy, the public in the U.S. feels for too long it has not been involved in the development of energy policy. The fact is, I think most Americans feel

until now energy policy in the U.S., as you felt, has been the exclusive domain of the oil giants, and they controlled the executive branch and the legislative branch, and we think they botched the job, just as you do. Mr. Parsky last night basically took the position that they should be left alone to continue to control the policy, and he objected to the idea that the Congress would question the very structure of the industry by suggesting divestiture of the integrated oil companies. I wonder whether you, Sheikh Tariki, would agree that perhaps the structure we have is not the most perfect structure and that we could generate more competition in the oil industry, and that it might benefit everybody if we had the industry broken down in a way that would stimulate freer competition, allow us to get back to the basic principles of free enterprise that at least in our economy are designed to provide a market that is best for everybody and especially for the consuming public.

Tariki: Well, of course, I have no objection for you all to do what you believe in this cooperation, and I always think that this part of the surplus money should be used to develop a new source of energy, not because here I am feeling like being so human, because this is also good for our country, because if you stop burning oil as a source of energy and let us use it as a source of chemicals and a feedstock for petrochemicals, we'll benefit more than all the money we give you to develop other sources of energy for heat. Therefore, you will find that all the people in OPEC and even OPEC itself will be willing to cooperate on that, because they want their oil to last much longer than the way it is now being burned. They used to call us, or somebody wrote that or I heard, that 300 years from now the scientists will call us savage, primitive, and ignorant in burning hydrocarbons.

Developed, Oil-Importing Nations Eastern Perspective

Mr. Masami Ishida
President, Petroleum Association of Japan

Mr. Chairman,
Distinguished Guests,
Ladies and Gentlemen:

It is indeed an honor for me to have been afforded the opportunity to make this presentation at The University of Texas that is so rich in tradition. Japan, as you all well know, is one of the developed petroleum-importing countries. It is in the capacity of a citizen of such a nation that I intend to discuss here today the various problems now facing the Japanese petroleum industry, and the outlook for its future.

CURRENT SITUATION

Consumption

The Japanese economy, through the 1960s, recorded a growth unprecedented in world annals (averaging 13.5% during 1960–1970). Consequently, petroleum consumption increased at the rate of almost 20% annually, with the result that Japan became the second largest consumer of petroleum, next only to the United States.

However, Japan's economy underwent a drastic change following the oil crisis in the Fall of 1973. As was the case in all other countries, the Japanese economy was plunged into confusion and a recession followed. As a result, our Gross National Product in 1974 recorded a minus growth (i.e. minus 0.5% during 1973–1974) for the first time in 30 years.

Fortunately, in 1975, our GNP recovered to show a modest growth (2.6% during 1974–1975), and the prospects are for a 5% growth of the economy this year.

These economic conditions were sharply reflected on the energy consumption in our country. With petroleum representing three-fourths of the total national energy consumption, its use fell from 5.3 million barrels a day in 1973 to 4.7 million barrels a day in 1974, and then went back to an estimated 5.1 million barrels

a day in 1975, though not sufficient to recover to the level of 1973. This was principally caused by a drastic reduction in the consumption of naphtha by the petrochemical industry, and of residual fuel oil for industrial purposes.

As we look at the consumption pattern of petroleum in Japan, it differs widely from that in the United States and the European countries. Firstly, the consumption of motor gasoline and middle distillates is relatively small, while that of naphtha for the petrochemical feedstocks and residual fuel oil for industrial purposes is proportionately large. This peculiarity is reflected in the fact that residual fuel oil represents more than 45% of the total consumption of petroleum. Secondly, the consumption for industrial use is extremely high, accounting for about 60% of the total, and thirdly, crude oil is being used for direct burning in power generation to the extent of a little less than 10% of the total oil consumption.

Exploration and Production

Japan has not been blessed with petroleum resources. Domestic production is minimal. With an output of 14 thousand barrels a day it can barely meet the country's demand for one day. More than 50 companies have been actively engaged in exploration and development in Japan and overseas, but the supply from these firms so far amounts to only 10% (500,000 barrels per day) of the total amount of imported crude oil.

Imports

As a consequence, Japan is almost wholly dependent for its oil supply on foreign sources. These supply sources are the Middle East, which provides 80%, and Southeast Asia, Africa, and the Communist nations which, altogether, meet the remaining demand.

Chinese oil, which has attracted attention of late, is an attractive potential source of supply because of its geographical proximity. However, at present, it represents only about 3% (160,000 barrels per day) of our total crude oil imports.

Refining

The Japanese petroleum refining industry expanded rapidly to meet a growing demand and now has attained a refining capability of approximately 6 million barrels a day. The distillation capacity of each refinery has reached the level of 150 thousand barrels a day—a world-wide level. However, because of the sluggish demand for petroleum products, these refineries are now operating at about 70% of their capacity. While environmental problems cast a shadow on the new construction and expansion of refineries, the additional refining capacities now being planned are expected to increase the total capacity to about 7.2 million barrels a day which is sufficient to meet demand until the mid-1980s.

One of the features of the Japanese refineries is that they are equipped with residual fuel oil desulfurization devices, because Japan is heavily dependent on Middle East high sulfur oil and the standards for sulfur oxides emission control are extremely severe. A hydro-desulfurizer of reduced crude, the first commercial unit of its kind in the world, was installed in Japan in 1967. The total hydro-desulfurization capacity for both reduced crude and heavy distillates now amounts to 1.2 million barrels a day.

Transportation

In order to reduce transportation costs of imported oil, Japan took the leadership in utilizing very large tankers. Japan has benefited from the fact that it is completely surrounded by sea and also has many natural harbors with deep waters needed by large tankers. All refineries have been located along the sea coast.

In addition, industrial centers are concentrated along the coast, which makes it possible to meet the requirements for domestic oil transport with coastal tankers. These meet about 60% of the demand, while the remaining 40% is met through the use of tank-cars and tank-trucks.

Because of the increasing traffic congestion affecting domestic transportation, the need for pipelines has been increasingly felt of late, but such installations have not yet become generalized, in contrast to the situation in the United States and in Europe.

Environmental Measures

One of the problems facing the Japanese petroleum industry is the environmental question. In addition to its limited geographical surface, Japan has little flat land. Industrial and residential areas are concentrated along the sea coast. The large consumption of petro-

leum has created, in particular, an atmospheric pollution problem caused by sulfur oxides and nitrogen oxides emissions.

To meet this problem, Japan has been striving hard to increase the import of low-sulfur crude oil, and moreover, to install hydro-desulfurizers and flue gas nitrogen oxides converters as well. At present, the petroleum industry devotes about 50% of refinery investments for environmental and safety measures.

Financial Problems

As I stated earlier, the oil crisis in the Fall of 1973 dealt a severe blow to the Japanese economy. Moreover, the suddenness and the extent of the increase in oil prices adopted by the OPEC placed the petroleum industry in an embarrassing position in that it found it difficult to obtain public understanding of the subsequent grave impact imposed upon the industry. This was coupled with the government's overall policy to control price increases.

Thus, the oil industry has been unable to pass its increased costs onto the prices of its products, with the result that it now faces a great financial difficulty.

The government last December established standard sales prices for petroleum products enabling the petroleum industry to gradually improve its financial situation, but the majority of companies are to suffer for a considerable period to come from a huge amount of losses.

Besides, as was the case in the United States and in Europe, the Japanese petroleum industry was looked upon by the general public as the principal culprit behind the inflationary wave. The industry is now striving to correct this unfortunate situation by actively seeking better popular understanding of the petroleum problem.

FUTURE OUTLOOK

Long-Term Demand & Supply

The Japanese government drew up in August 1975 a long-term energy demand and supply plan which foresees a demand for the total energy of 13 million barrels a day of oil equivalent in 1985, even should a 10% conservation in energy consumption be achieved. Since energy demand in 1974 was around 7 million barrels a day of oil equivalent, this projection anticipates a yearly increase in demand of 5.8% (GNP growth rate of 6.2% during 1974–1985). This is nearly half of the demand growth rate recorded before the oil crisis, but is nevertheless higher than those of other major industrialized countries.

This plan envisages the increased development and utilization of non-petroleum energy resources such as atomic power, geothermal energy, and liquefied natural gas, in particular.

As a result, dependency on petroleum is slated to decrease, according to the plan, from 74% in 1974 to 64% in 1985. However, the quantity of oil imports will nevertheless increase from 5.2 million barrels a day to 8.3 million barrels a day respectively (at the yearly average rate of 4.3%). How to obtain a secure supply of these increasing oil requirements is a major problem for our country.

Measures for a Stable Oil Supply

I should now like to outline the measures for our future oil supplies.

Conservation

Conservation in the consumption of petroleum is an important means that oil-consuming countries will have to pursue in formulating measures for their oil supply so as to effectively utilize oil resources and improve the demand and supply situation.

This is especially true for Japan which consumes large quantities of petroleum, and a great emphasis should be given to the conservation of the energy for industrial use, which accounts for as much as 60% of the total energy requirements.

The Japanese government, in keeping harmony with economic growth, intends to follow short- and long-term policies that would improve efficiency of energy utilization and convert the country's industrial structure into one that conserves energy. Through these steps, the government intends to reduce energy consumption by 10% or 1.4 million barrels a day of oil equivalent in 1985.

Exploration

As I have explained before, Japan will have to depend in the future, as it does today, on petroleum imports. But at the same time, in order to secure a stable oil supply, it will have to further oil exploration and de-

velopment, on a scale commensurate with its national strength, in cooperation with oil-producing or oil-consuming nations.

Taking the successful development of oil resources in the North Sea and Alaska as an example, it should envisage a more active exploration and development of such resources, particularly in the continental shelf around Japan as well as in the Far East regions including the East China Sea which is believed to have enormous oil deposits.

When oil from these areas developed by Japanese enterprises is imported in increasing quantities, it will serve in augmenting the world's crude oil supply and thus lead to stabilization of oil supply, not only for Japan, but for other countries as well.

Development of Alternative Energy Resources

Japan also intends to engage actively in the development and utilization of alternative energy resources to replace petroleum.

The Japanese government has set its supply target of non-oil energy in 1985, among others, at 9.6% for nuclear energy, 7.9% liquefied natural gas and 0.5% geothermal energy, respectively, of the total energy requirements. It is to be expected that Japan will continue to increase its dependence on such resources of energy after 1985.

In addition, Japan is preparing to co-operate with various countries in the research and development of such energy resources as low-BTU gas, tar sands and oil shale.

Public attention has also been drawn to the so-called "Sunshine Project," designed to carry out research into and the development of various alternative sources of energy. This project, elaborated in 1973 and actively pursued since that time, has as its objective the large-scale utilization of solar energy and nuclear fusion, which are virtually inexhaustible, and synthetic natural gas as well.

Stockpiling

The stockpiling of petroleum is another problem. It is only natural that an oil-importing nation should endeavor to increase its stocks to a reasonable extent to meet a possible reduction or interruption of oil supply, which may result from political or other unforeseen developments.

In this connection, a law was promulgated in December of last year which is designed to raise by March 1980 the present 70-day oil reserve to 90 days by putting up an additional 200 million barrels.

Since Japan's oil imports are far larger than those of European countries, the absolute quantity it will have to procure to maintain the same level of 90-day reserve will come to more than twice that of any individual European country. Nevertheless, efforts are being made by both the government and industry to attain this target.

Economic and Technical Co-operation with Developing Countries

Japan has adopted a policy of extending economic and technical co-operation and assistance to developing countries, including oil-producing nations, for the implementation of their development projects, in order that a mutual interdependent relationship be established within the framework of the global economy.

This is because it is the only way for Japan, poor in natural resources, to survive. By importing raw materials including oil from developing countries and manufacturing them into finished products for export to these countries, Japan could contribute to the promotion of international trade. We believe this is the mission of Japan in this world.

Based on this standpoint, Japan intends to play this role more actively than it has up to now, by contributing its appropriate share to the economic and technical assistance to these developing countries, through the channels of international organizations such as the United Nations, and/or through bilateral arrangements.

International Petroleum Problems

I now wish to explore ways of solving the world's petroleum problems from the standpoint of a developed oil-importing country through the valuable experience learned as a consequence of the oil crisis.

Security of Supply

The supply of oil throughout the world today has been improved by the reduction of demand in the major oil-consuming countries. However, the political and economic atmosphere surrounding oil supply still remains unstable, causing a serious problem of how the increasing oil demand by the consuming countries can be met in the future.

Regardless of what steps the oil-consuming countries may take, it cannot be denied that, judging from the global distribution of petroleum resources, the existing major producing areas such as the Middle East, Africa, and others, will remain the main sources of supply. Therefore it results that the oil-producing nations will continue to play an important role with a heavy responsibility in the picture of the world oil supply. Needless to say, the consuming countries should, on their part, take the various measures I have earlier stated, such as conservation, exploration, and development of alternative resources of energy, while taking into consideration the limited availability of oil resources. Accordingly, I hope sincerely that long-term and stable supply arrangements will be established between the oil-producing and importing nations at the earliest possible opportunity.

Price Stabilization

Another problem facing importing countries in order to secure a stable supply is that of the price of oil.

The sudden rise in oil prices at the time of the 1973 oil crisis dealt a serious blow to the economies of all countries in the world, especially such developing countries that do not produce oil.

Now that the world economy is showing signs of recovery, we must prevent the world, by all means, from again plunging into confusion. The producing countries claim that further rises in oil prices are needed to compensate for the progress of inflation in the advanced industrial nations as well as the loss in value of the dollar. However, should the price of oil and the inflation in industrialized nations develop into a spiral escalation, it will be impossible to seek a stable world economy.

It is indeed the so-called "chicken and egg argument" whether anti-inflationary measures in industrialized nations should have priority over the stabilization of oil prices or not. Therefore, it is most desirable for a stable world economy to see an international consensus created to determine an oil price that would be fair and equitable to both the oil-producing and consuming countries.

International Co-operation

It is evident that interdependence is growing today in international politics and economics. The oil crisis drove home the fact that the world economy was closely bound to the price and supply of energy.

In order to solve the problem of energy, with oil as a nucleus, there can be no doubt that international co-operation on a wide scale is imperative, since there are inherent limits to the capability of oil-producing or consuming countries individually to achieve a solution.

It is therefore necessary for the producing and consuming countries, each understanding the other's viewpoint, to establish a firm worldwide framework, through dialogue and harmony among nations, for the stabilization of the price and supply of oil as soon as possible.

In this respect it is most welcome that mutual understanding among nations is deepening through the International Energy Agency and the Conference on International Economic Co-operation, thus opening the path to talks for a comprehensive solution of the energy problem centered upon oil. My country looks upon these developments with great expectations. I believe that this will also lead the way to promoting the interests of the developing countries.

In terminating, I wish to recall the slogan "Petroleum for the Welfare of Mankind" adopted by the World Petroleum Congress held in Tokyo last May, and pray that world peace and prosperity may be promoted through petroleum.

Thank you.

TABLE 1
Primary Energy Demand and Supply

	Actual								Forecast				Annual Average Growth (%)						
	FY 1960		FY 1965		FY 1970		FY 1974		FY 1980		FY 1985								
	10^{13}Kcal	%	10^{13}Kcal	%	10^{13}Kcal	%	10^{13}Kcal	%	10^{13}Kcal	%	10^{13}Kcal	%	60-65	65-70	60-70	70-74	74-80	80-85	74-85
Energy Demand:																			
Before Saving									566.0		784.0						6.7	6.7	6.7
(Crude Oil Equivalent)									(10,382 MB/D)		(14,380 MB/D)								
	93.7		165.6		310.5		383.5						12.0	13.4	12.7	5.4			
After Saving	(1,720 MB/D)		(3,037 MB/D)		(5,696 MB/D)		(7,036 MB/D)		530.0		710.0						5.6	6.0	5.8
(Crude Oil Equivalent)									(9,721 MB/D)		(13,023 MB/D)								
Primary Energy Supply:																			
Hydro Power	14.3	15.3	18.7	11.3	19.6	6.3	20.8	5.4	22.3	4.2	26.0	3.7	5.5	1.0	3.2	1.5	1.2	3.1	2.1
Nuclear Power	—	—	0.0	0.0	1.1	0.4	4.8	1.3	23.4	4.4	68.2	9.6	—	—	—	44.0	30.0	23.9	27.2
Geothermal	—	—	—	—	—	—	—	—	0.7	0.1	3.6	0.5	—	—	—	—	—	38.4	—
Coal	39.5	42.1	45.5	27.4	64.4	20.7	63.8	16.6	84.2	15.9	92.1	13.0	2.9	7.2	5.0	-0.2	4.4	1.8	2.2
Indigenous	32.8	(35.0)	31.9	(19.3)	25.1	(8.1)	14.0	(3.6)	13.4	(2.5	13.3	(1.9)	-0.5	-4.7	-2.6	-13.6	-1.1	0.0	-0.6
Imported	6.7	(7.1)	13.6	(8.1)	39.3	(12.6)	49.8	(13.0)	70.8	(13.4)	78.8	(11.1)	15.2	23.6	19.4	6.1	6.0	2.2	4.2
Petroleum (Incl. L.P.G.)	35.4	37.7	96.7	58.4	219.8	70.8	285.3	74.4	366.7	69.2	453.7	63.9	22.3	17.9	20.0	6.7	4.3	4.3	4.3
(Crude Oil Equivalent)	(649 MB/D)		(1,774 MB/D)		(4,031 MB/D)		(5,234 MB/D)		(6,726 MB/D)		(8,322 MB/D)								
Indigenous	0.6	(0.6)	0.7	(0.4)	0.9	(0.2)	0.7	(0.2)	1.6	(0.3)	3.8	(0.6)	3.1	5.2	4.2	-6.1	13.4	19.2	16.0
(Crude Oil Equivalent)	(11 MB/D)		(13 MB/D)		(17 MB/D)		(13 MB/D)		(29 MB/D)		(70 MB/D)								
Imported	34.8	(37.1)	96.0	(58.0)	218.9	(70.6)	284.6	(74.2)	365.1	(68.9)	449.8	(63.3)	22.5	18.0	20.2	6.8	4.3	4.3	4.3
(Crude Oil Equivalent)	(638 MB/D)		(1,761 MB/D)		(4,014 MB/D)		(5,221 MB/D)		(6,697 MB/D)		(8,252 MB/D)								
Natural Gas	0.9	1.0	2.0	1.2	2.7	0.9	2.7	0.7	4.5	0.8	9.5	1.3	17.3	6.2	11.7	0.0	8.6	16.3	12.0
L.N.G.	—	—	—	—	1.3	0.4	5.1	1.3	27.4	5.2	56.1	7.9	—	—	—	41.0	32.3	15.4	24.3
Others	3.6	3.9	2.7	1.7	1.6	0.5	1.0	0.3	0.8	0.2	0.8	0.1	-5.6	-9.9	-7.8	-11.1	-3.6	0.0	-2.0
Total	93.7	100.0	165.6	100.0	310.5	100.0	383.5	100.0	530.0	100.0	710.0	100.0	12.0	13.4	12.7	5.4	5.6	6.0	5.8
Ratio of Imported Energy Supply	44.2%		66.2%		83.5%		88.5%		87.5%		82.4%		—	—	—	—	—	—	—

Reference Data on Japanese Petroleum Industry
Source: Ministry of International Trade and Industry, Japan

Abbreviation:
FY : Fiscal year ending March
CY : Calendar year
MB/D : Thousand barrels per day

TABLE 2
Petroleum Product Demand

	FY 1960		FY 1965		FY 1970		FY 1974		Annual Average Growth (%)			
	M B/D	%	M B/D	%	M B/D	%	M B/D	%	60-65	65-70	60-70	70-74
Domestic Demand:												
Gasoline	101	19.7	187	13.5	362	10.8	467	10.9	13.1	14.1	13.6	6.6
Naphtha	—	—	114	8.3	476	14.2	594	13.9	—	33.1	—	5.6
Jet Fuel Oil	3	0.6	9	0.7	20	0.6	32	0.7	24.6	17.3	20.9	12.5
Kerosine	36	7.1	90	6.5	273		369	8.6	20.2	24.9	22.5	7.8
Gas Oil	37	7.2	96	7.0	207	6.2	272	6.4	21.0	16.6	18.8	7.1
Fuel Oil	320	62.5	832	60.2	1,816	54.0	2,049	47.8	21.1	16.9	19.0	3.1
Lubricating Oil	14	2.7	25	1.8	42	1.2	38	0.9	12.3	11.0	11.6	-2.4
Asphalt (1)	1	0.2	4	0.3	10	0.3	13	0.3	32.0	20.1	25.9	6.8
L.P.G.	—	—	10	0.7	24	0.7	36	0.8	—	19.1	—	10.7
Crude Oil for Direct Burning	—	—	14	1.0	133	3.9	415	9.7	—	57.0	—	32.9
Total	512	100.0	1,381	100.0	3,363	100.0	4,285	100.0	21.9	19.5	20.7	6.3
Export Demand:												
Various Products (2)	52		173		170		399		27.2	-0.4	12.6	23.8
Grand Total (3)	**564**		**1,554**		**3,533**		**4,684**		**22.5**	**17.9**	**20.1**	**7.3**

Note: (1) Including grease and paraffin. Quantity in metric tons per day.
(2) Principally bunker fuel oils for international vessels.
(3) Excluding refinery loss and inventory changes.

TABLE 3
Crude Oil Imports by Origin

	FY 1960		FY 1965		FY 1970		FY 1974	
	M B/D	%	M B/D	%	M B/D	%	M B/D	%
Middle East:								
Iran	21	3.7	326	21.6	1,508	42.7	1,269	26.7
Saudi Arabia	106	18.7	290	19.2	494	14.0	1,058	22.3
U.A.E.	—	—	8	0.5	201	5.7	491	10.3
Kuwait	216	38.0	356	23.6	314	8.9	432	9.1
Neutral Zone	34	6.0	245	16.2	364	10.3	268	5.6
Qatar	2	0.3	12	0.8	4	0.1	5	0.1
Iraq	72	12.7	96	6.4	—	—	45	0.9
Others	—	—	—	—	103	2.9	108	2.3
Total	451	79.4	1,333	88.3	2,988	84.6	3,676	77.3
Africa:								
Nigeria	—	—	—	—	—	—	82	1.7
Libya	—	—	—	—	8	0.2	77	1.6
Others	—	—	—	—	39	1.1	13	0.3
Total	—	—	—	—	47	1.3	172	3.6
Southeast Asia:								
Indonesia	64	11.3	106	7.0	467	13.2	642	13.5
Others	22	3.9	3	0.2	7	0.2	165	3.5
Total	86	15.2	109	7.2	474	13.4	807	17.0
America:								
Venezuela	0	0	8	0.5	11	0.4	7	0.1
Others	2	0.3	1	0.1	1	0.0	—	—
Total	2	0.3	9	0.6	12	0.4	7	0.1
Communist Areas:								
China	—	—	—	—	—	—	88	1.9
U.S.S.R.	29	5.1	50	3.3	10	0.3	4	0.1
Others	—	—	9	0.6	—	—	—	—
Total	29	5.1	59	3.9	10	0.3	92	2.0
Grand Total	**568**	**100.0**	**1,510**	**100.0**	**3,531**	**100.0**	**4,754**	**100.0**

TABLE 4
Petroleum Product Imports

	FY 1960		FY 1965		FY 1970		FY 1974	
	M B/D	%	M B/D	%	M B/D	%	M B/D	%
Gasoline	1	1.4	1	0.4	—	—	—	—
Naphtha	—	—	13	5.2	116	22.8	123	24.2
Kerosine	—	—	—	—	3	0.6	2	0.4
Fuel Oil	67	95.7	213	85.2	295	57.9	200	39.4
Lubricating Oil	2	2.9	5	2.0	6	1.2	3	0.6
L.P.G.	—	—	18	7.2	89	17.5	180	35.4
Total	**70**	**100.0**	**250**	**100.0**	**509**	**100.0**	**508**	**100.0**

Discussion

Question: I was very much interested in this lecture of Mr. Ishida and I fully agree with him. My country has very much in common with Japan in regard to per capita energy consumption. Czechoslovakia is in third place in the world after the U.S. and Canada, even before Britain, Germany, and Japan. So I think in a certain way we have very similar problems and I confirm that after 1973 we were affected very much by the rise of the oil price. Although we get oil, we are dependent on oil from the Soviet Union, and we also import natural gas from that country. Nevertheless, the prices had risen and we had serious economic problems afterwards. I must stress here not only our country and Eastern Europe is dependent now on this natural gas from the Soviet Union, but also Western Europe. Through our country there goes now a pipe line for natural gas to Western Germany, Austria, and Italy. And so in a certain way this dependence is interwoven in Europe. But what I wanted to add is that I am rather sorry that there is so little cooperation between Czechoslovakia and Japan for example, as regards to certain kinds of research on this similar problem concerning the very high energy consumption of the highly industrialized country and virtually no oil production on the territory of these two countries. Thank you.

Ishida: It is true that we have no real economic cooperation with Czechoslovakia. But as you know, among the Western countries there has been established an agency called the International Energy Agency which was created to meet the need for international cooperation among consuming countries. It started with emergency countermeasures like stockpile reinforcement plans, but today it is actively seeking a long-term plan which aims at the standardization of energy demand and supply of the world. The thesis of the long-term plan is the conservation of energy consumption, development of energy, and research and development of new energy. We believe that this type of long-term program will prove quite useful for all the countries of the world, and we would hope that Czechoslovakia might join in this kind of international negotiations.

Question: Thank you Mr. Ishida for that good lecture. I work in an oil company that is owned 50% by Texaco and the other 50% by the Standard Oil Company. I understand they have an interest in Japan, too. My question is, what do you think of the giant oil companies that work in your country, whether they consider your interests or whether they think only of profit?

Thank you for your answer.

Ishida: About the international oil companies, they are very rich in financial capabilities, and they have a great deal of experience, and they are actively engaged in all phases of the energy industry, covering petroleum, nuclear energy, etc. Japan is counting very much upon the important role that they will continue to play in the worldwide energy supply in the future. Japan depends upon the major oil companies for 60% of its oil requirements and will be required to maintain a very close relationship with them.

Question: I found the speech made by the honorable Japanese representative very enlightening. He mentioned two things that called my attention. One is—perhaps due to the fact that Japanese consumption of oil is going to increase—perhaps Japan should try to create some kind of a stock to meet a possible reduction in imports from abroad. He said Japan is vulnerable to oil imports. Now then what to do? I had an idea I wanted to convey to the honorable representative from Japan that goes like this: the idea is to try to associate as much as you can with the developing oil-exporting countries on several fields such as refining, petrochemicals, but most of all engineering—basic engineering, detail engineering, and the development of technology and know-how outside of Japan in association with the producing countries. So my question would be—I know you are very capable of doing things like that—Japanese are mentally very agile—so my question is, would you be willing to do that?

ishida: It is true that Japan is very poor in energy resources, but it is also true that there are only a few countries that possess all kinds of resources. Therefore, we believe that the nations of the world will have to help each other with resources in order to live in peace. Fortunately, Japan has highly edu-

cated and very industrious human resources which we think we can contribute to the welfare of developing countries and thus push forward the international cooperation and independence for the sake of national security. In this sense Japan is firmly determined to stand as a trading nation under a guidance of peaceful spirit as stipulated in its constitution. I think this may apply to the first question.

There are quite a number of proposals being put forward to Japan from the producing countries such as oil refineries to be put up in the producing countries or petrochemical industries, steel industries, and some other sort of installations to be used for their industrial purposes. I think there has been a great deal of progress already made in the past and we think that Japan will strive hard to make further efforts to contribute to the welfare of the producing countries or other non-producing countries as they develop.

Question: You mentioned that the improvement in the supply picture is due to the slack in the demand in oil-consuming nations. However this may be short-lived. There is some indication that the demand is picking up. For example, in the U.S. it is projected that in this year it could be more than 6% over 1975. What I'd like to ask is, What are your projections for this increase in demand for the rest of the world? You have presented some numbers for Japan, but I would like to know your projections for the rest of the world, for energy in general and oil in particular.

Ishida: We haven't brought here any data concerning the other nations. I think there have been a number of presentations made in yesterday's session and today's which may answer the question.

Question: I would like to ask you, please, what's the Japanese point of view of alternative sources of energy and what kind of research is being done in Japan about alternative sources of energy?

Ishida: As I have mentioned, we have a project called Sunshine Project which has been actively pursued since 1974 by the government and the Corporation of National Research Institute, private enterprises, universities, etc.

This project consists of four sources of energy: solar, geothermal, coal, and hydrogen. Its target is developing five million barrels per day of oil premium, of new types of energy resources by the year 2000. About 2 million barrels per day each of solar and hydrogen resources is projected. The government has already allocated 3.6 billion dollars to be spent for this project during 1973–75, and they have established the annual budget for 1975 which is 1.5 billion dollars. Almost all the energy resources to be developed under Sunshine Project are still in a preliminary stage of development, except geothermal resources which already have four power stations in operation at a total capacity of 50 kilowatts an hour. As regards coal gas power generation, natural gas, and solar power generation, research is either in progress in small size power plants or is only in its beginning stages.

Question: After the strong and uncomfortable swing to a minus gross national product growth in 1973 and 1974, has Japan thought of slowing down its gross national product growth as a deliberate policy for both government and industry? This is in line with the limits to growth idea which is now more practically thought of as selective growth, less consumption of all natural non-renewable resources as well as oil, especially by the developed industrialized countries.

Ishida: I have mentioned that the Japanese economy grew at a very high rate, averaging 10.7% annually for the 10-year period ending in 1970 and then slowed down to 7.8% annually during 1970–73. But after the oil crisis, our GNP growth went down to minus 0.5%. The Japanese economy has begun to show a gradual recovery with 2.6% growth rate in 1975 and 5.6% in 1976; it's further expected that about 6% growth may be achieved on a medium and long-term basis. I think this government projection of 6% is designed to encompass the current energy situation, and such a moderate growth would be intended by the government.

Developed, Oil-Importing Nations
Western Perspective

The Honorable Ronald Wm. Brown
Labour Member of Parliament, United Kingdom

The traumatic experience of October 1973 was as significant to the oil-importing developed nations of the Western world as it was to any other area. Each of our European nations had built its economic and industrial strategy on the availability of oil at low stable prices. To suddenly discover that the flow of oil could be interrupted and the price per barrel quadrupled created a climate which reflected anger, fear, near-panic, and a sense of isolation.

There can be little doubt that such an experience has had the effect of focussing the attention of all responsible people on the need for thinking and planning multilaterally. The task of solving the vast complex of problems, covering the whole economic spectrum that faces our nations, clearly cannot be achieved by any one country or groups of countries.

To a limited extent this lesson had been appreciated in Europe long before that fateful October. One recalls the Coal and Steel Community being established in 1951 to plan the orderly use of such energy resources, and Euratom was established to give increased support for the European nuclear energy industry. Both of these initiatives had some success, but it is somewhat ironic when one considers that their failure to achieve full potential was the apparent availability of abundant supplies of cheap oil and coal.

The source of this cheap oil was of course from the Middle East where due to the rapid expansion in oil production which coincided with the decision by the United States to introduce export controls on oil in order to protect its market, resulted in a surplus capacity, and much of the new production found its way into Europe. In turn, this enabled the major oil companies to lower the "posted prices" for their Middle East crude

oil and reduced the price per barrel received by the oil-producing countries. As a direct result of all this, the oil producers not unnaturally sought ways of protecting their interest and income and set up the Organization of Petroleum Exporting Countries.

Europe continued to place itself more and more dependent on OPEC by increasing its demand for their oil, and when the crunch came the experience was all the more painful.

Every energy-importing country has had to embark upon a rapid re-adjustment to a situation where oil has moved from being a cheap marginal fuel to an expensive commodity. Almost every facet of our national or international life has been affected—our relations with other countries, international finance and trade, domestic economic policy, industrial policy, transport policy.

If I take the situation as it affects the United Kingdom, it will I think serve to illustrate the situation more clearly. Over the past few years the UK energy policy has been geared to the run-down of the coal industry, investment in the publicly owned energy industries, and the role of nuclear power in the energy field. As a result of our experience, we have now revised our energy policy to take into account rather different aspects.

(a) Greater emphasis must be given to the educating of energy consumers in the more efficient use of fuel, thereby achieving energy conservation. Whilst this will not solve our problems, it will make a contribution to their solution.

(b) We must ensure that the best possible use is made of our energy resources, thereby satisfying the need for security and availability. In addition this will assist in no small way to improving our balance of payments.

(c) Our energy research and development programmes, both nuclear and non-nuclear, must be of such an order that will keep us well placed to exploit long-term developments in energy supply as they arise.

(d) It is of vital importance that the UK play a leading role in all international organization such as the EEC, OPEC, and ILA. The UK has much to contribute in this field.

It might be to advantage if we briefly recall the present situation in the UK with regard to coal and nuclear power. The coal industry had been run-down from a deep-mined output of 210 million tons and a labour force of 700,000 people during the middle fifties to 130 million tons and a labour force of less than 270,000 in 1973. Even so it is still the largest coal industry in Western Europe and it still supplies about 35% of our energy needs.

Arising from recommendations made by a group representing Government, National Coal Board, and the trade unions concerned, set up by the government in 1974 to examine the coal industry, the opportunity is given for a viable future. This should enable the industry to stabilize deep-mined output of coal at around 120 million tons a year, together with an additional opencast output of about 15 million tons a year.

The possibility of a total output even higher than 135 million tons is not ruled out. It will therefore be possible to make greater use of the industry.

Nuclear Energy

In nuclear power the major decision on nuclear reactor policy was made in July 1974 when the Government decided to institute a programme over the next four years of up to 4000 MW of Steam Generating Heavy Water Reactors for electricity generation. The design and development plan for a 600–660 MW reactor unit and its time-table for construction is now being worked up. Work on the existing five Advanced Gas Cooled reactors is continuing, and their completion over the next three to four years is anticipated. The prototype Fast Breeder Reactor at Dounreay is being brought up to full power, and consideration is being given to exploring the options for international co-operation on the system's future development.

North Sea Gas

Development of North Sea gas has been a major achievement both offshore and onshore. Only ten years after the first discovery of gas in the North Sea was made, natural gas now provides almost 95% of all gas supplies in Great Britain.

North Sea Oil

With the North Sea oil coming ashore in steadily increasing quantities, fields already declared commercial will equal all our domestic requirements by 1980 and will make the United Kingdom the tenth largest oil producer in the world. It is also important to remember that nowhere else in the world has oil been brought up

from these depths in these conditions. The Forties platforms which stand in over 400 feet of water are of a scale and technical sophistication far above any piece of offshore drilling equipment previously produced in any country. It is therefore all the more important that the resources which they make available to meet our energy needs should be used to confer maximum benefit on the community as a whole.

In 1975 oil production amounted to 1 million tons, but by the end of this year five more fields will have come on stream giving an estimated production of 15-20 million tons, about a fifth of our national needs. We are on target to reach a level of production equivalent to our total national consumption by 1980. Reserves are estimated to be about 4000 million tons, which should enable us to sustain a comparable production level for a good many years thereafter.

Of course, the investment demands of North Sea development are massive. The estimates suggest that development investment in oil fields already discovered and likely to be developed by 1980 in the UK sector of the North Sea may in total amount to £5–6 billion in 1975 relative money values (this includes the cost of discovery, appraisal, and the development of the fields in question together with the estimated cost of certain pipelines and beach terminal equipment, but nothing further inland). Of this, £2 billion was spent by the beginning of 1976 and the remaining investment in these fields will largely be completed by 1980.

It is, of course, mainly oil field development which generates the industrial activity associated with the North Sea. In the last 18 months British industry has completed and installed six major production platforms, bigger than any previously built in any other part of the world; and the success in the highly complex and difficult operation of installation has so far been 100%. Further platforms are under construction in UK yards for float-out this summer or over the next 18 months. Each basic structure has an average value of perhaps £50m and represents a formidable technological and industrial achievement. The modules service and equipment ancillary to platforms have, of course, also generated much new work for British industry.

The direct benefits of getting our oil and gas ashore are very great, but it is not only the direct benefits with which we are concerned. In the past 18 months the steadily increasing number of major finds of hydrocarbons in the North Sea has established beyond doubt that Britain has a large and continuing market on its doorstep in supplying the equipment necessary to bring the oil and gas ashore. As an indication of size of this market, the value of the orders placed in 1974 was just under £1.300 million and the 1975 figure is expected to work out at about the same. Perhaps even more important, the world market for offshore hardware continues to grow as the search for hydrocarbons moves into new waters, and the Government is now turning its attention to encouraging UK industry to take advantage of the opportunities in this wider market, which is estimated to be worth around £3 billion to £5 billion over the next five years.

The Government's policy, pursued through the Offshore Supplies Office (OSO) from its headquarters in Glasgow, is that British industry should supply, on a competitive basis, an increasing share of the domestic offshore market. Our aim is to ensure that British firms are given a full and fair opportunity to compete for business, and in this respect we are doing no more than other countries are already doing. In this way UK offshore supplies industry can be built up on a firm foundation which will provide the springboard to enable it to compete effectively in the international offshore market.

In economic terms, the North Sea oil benefits the nation in two ways. It improves the balance of payments and it adds to the real national income. In 1975 the UK consumption of oil was approximately 87 million tons, and virtually all of this had to be imported at a net cost of about £3.100 million which was equivalent to almost the whole of the UK deficit on visible trade account for 1975. The discovery and development of North Sea oil is changing the situation. By 1980, when North Sea fields will be producing 100–130 million tons of oil annually, which is estimated to be equivalent to annual UK needs five years from now, there will be a substantial saving in overseas expenditure. This saving will not be equivalent to the gross value of the oil production estimated to be worth some £5 billion at 1975 prices, since there are some foreign exchange costs in producing North Sea oil (e.g., the cost of imported goods and services, outflow of interest, profit, and dividends). Because of this, the current account impact by 1980 is expected to be about £3 billion at 1975 prices. But let me explain further.

As I have already mentioned, our oil production in 1980 will be enough to provide net self-sufficiency in oil for this country. This will of course offer the UK enormous advantages not only in terms of our balance of payments but also in terms of availability and security of supply. But it does not mean that the UK oil market will be entirely supplied from the North Sea: we shall, for instance, continue to import some heavier crude oils for particular purposes and market some North Sea oil abroad, in crude or refined form, to ensure that we obtain full value for its high quality. But we shall be much better placed than most other industrialized countries. Nevertheless, important though North Sea oil is going to be to us, it would be very wrong to see it as the final and complete answer to all our energy problems.

The emergence of considerable resources of oil on our energy scene has also brought about some vital modifications of our domestic policies in relation to it. In March 1973 The Public Accounts Committee published its *Report on North Sea Oil and Gas*. This report made it clear that loopholes in the existing taxation arrangements and the rates of tax applicable at the time would not bring a fair share of the revenues to the British people who owned these valuable resources. It became obvious that new policies had to be developed to meet the situation.

The objectives in the field are being achieved through the provision of the Oil Taxation Act which became law earlier last year. The Act introduced a completely new tax, the Petroleum Revenue Tax, specially designed for the particular circumstances of operations in the North Sea. The tax takes into account the very different circumstances of different fields so as not to prevent the development of any marginal ones and to leave the companies investing in the North Sea with an adequate return on their investment. The Act has also introduced a "ring fence" which makes it impossible for the oil companies to offset losses incurred in their operations elsewhere against profits derived from the North Sea.

Important as these measures are, they could not by themselves secure for the nation a stake in the valuable oil and gas resources nor any voice in the decisions affecting their exploitation. The Government is, therefore, convinced that majority state participation in licences for commercial oil fields is the best way the nation can share fully in the benefits of North Sea oil. Majority participation will be a condition of future licences. Where existing commercial fields are concerned, majority public participation is being achieved on a voluntary basis. Eight companies have up to now publicly accepted the principle of participation and discussions continue with these and other companies.

The state's participation rights in the UK sector of the Continental Shelf will be exercised by the British National Oil Corporation (BNOC) for which the Petroleum and Submarine Pipe-lines Act 1975 provided the legal framework. BNOC came into existence on 1st January under the chairmanship of Lord Kearton. The BNOC will act in partnership with private commercial companies and will be subject to the licence in the ordinary way. The BNOC also has powers to enter into the full range of oil activities including engaging in downstream activities such as oil refining. In carrying out these functions the BNOC will be required to act commercially, and it will not be permitted to confer any unfair advantage on any downstream subsidiaries. Another important role will be that of advising the government on oil matters and performing other functions on the government's behalf. The Board of the BNOC, unlike that of other public corporations in the United Kingdom, includes two members of the Civil Service who will act as channels of communication between the BNOC and the Government. In this way both will be well informed of each other's thinking. The BNOC, however, will not perform any regulatory function which will continue to be reserved to the government.

The UK recognises its good fortune that by 1980 we will be self sufficient in our energy requirements including oil, gas, coal, and nuclear energy. It is planned to export at least a third of the crude oil, having regard to the quality of North Sea oil, with its low sulphur content, since we shall wish to remain substantial importers and exporters of both crude and products.

Turning briefly to the IEA, it cannot be gainsaid that individual nations are only motivated to press for international action when it concerns self interest. The getting up of IEA was a classical example where self interest motivated nineteen nations to join together in seeking a solution to oil supply problems.

Now that broad agreement has been reached on an International Energy Programme, action can be taken

to implement its objectives, the most important features of which include a scheme for sharing oil in an emergency, co-ordinated efforts at energy conservation, and in the longer term the programme of co-operation is designed to accelerate the development of alternative sources of energy within the IEA countries and outside, through:

(a) Specific measures of assistance to increase and stimulate investment on a project-by-project basis.

(b) A general measure of cooperation between participating countries—to encourage and safeguard new investment in the bulk of conventional alternative sources of energy—to ensure that imported oil is not sold in their domestic markets below a price corresponding to $7 a barrel f.o.b.

(c) Cooperation in the production of additional energy from individual energy sectors.

(d) Encourage and promote new and beneficial technologies for the efficient production and utilization of energy.

(e) Work toward the removal of legislative and administrative obstacles and discriminatory practices to the realisation of the programme and so contribute to an efficient functioning of the world energy market.

These are giant steps in the field of international co-operation and when fully implemented will have a profound effect upon the world energy market.

Whilst October 1973 produced a shock wave that reverberated round the world, the spin-off is a recognition of the fundamental fact that in the energy field all nations are interdependent.

Let us hope we have all learned the lesson.

Discussion

Question: The cost of securing one barrel of oil a day in the North Sea is around $10,000. If you take the price of, say, $10 per barrel, which is higher over there, and you divide the total income, you get in a year's time on the investment, which is 10,000, a return of 37%, which isn't bad. Now, then, if you bring up the price just a little bit, then your rate of return would be even higher, so now you have become sort of partners with us. From the distance you're still not within OPEC but you're going to be for sure. My question is this: You have already become a partner with us, the members of the OPEC organization, regarding price, because you are sort of helping us to get the price at a high level, and you're bringing it up, with us at a high level too. The question is, are you really decided to help OPEC goals, if you become a member of OPEC in due time? Don't forget one thing, in the U.S. the Good Neighbor policy is well known as it is down in Venezuela and other places in Latin America; but the way in which we express it is that we are the good ones and they are the neighbors—be careful.

Brown: We are not members of OPEC.

I was merely indicating I am happy for myself to receive the joining card from OPEC just to study the form and see what it's like. (I really observe that you well might want us to lead you in the attack on the problem for yourself.) Your price is your responsibility; one can multiply anything by something and get some astronomical figures. All I can tell you is that the pricing policies we are observing is one which is generally agreed with our partners in the EEC as well as elsewhere. I think our attitude to OPEC can best be summarized, if you'll forgive me for one moment, by reading a document. I was privileged on behalf of our select committee on Science and Technology from our Parliament to go to the Middle East to have a look at the issue as it were, on the ground instead of just talking about it. We went and actually saw it. We went to Kuwait and Abu Dhabi, and it was a fascinating experience talking to the OPEC leaders as well as to the people in Kuwait and Abu Dhabi. Let me read to you the final paragraph of the report to the House of Commons. We were required to report to them, and therefore we had to publish a report for their discussion and decision making. So what I am giving you is the final conclusion of the report we issued. The sub-committee said this:

> "For a number of reasons, the price of oil is likely to remain fairly stable in the foreseeable future, barring the use of oil prices as a political weapon. Firstly, there has been a sharp fall in demand caused by the economic recession and the increased price, and we heard that there was in effect competition between the producing countries through the use of such devices as adjustments of equality premiums, general credit terms, and barter deals. Secondly, a number of states had embarked upon ambitious development plans and needed oil revenues to pay for these. Thirdly, we heard concern expressed about the effect of high oil prices on the economies of developing countries and of Western Europe. However, against all this it must be borne in mind, oil is the principal asset of many of the producing countries and it is therefore in their interest to maintain as high price as possible through a general concensus as the broad level of prices to be charged. We are also aware that the profitability of the very considerable British investment in North Sea oil is sensitive to world prices. We were conscious of the fact that the UK was seen as a valued partner in reducing economic dependence on oil and establishing an industrial base which would provide a sound future for the period after the state's oil resources had been fully exploited. A parallel was seen with the British position in the post North Sea oil era. The states were keen to use the British expertise to help establish the necessary industries. There are, therefore, a number of matters of mutual interest to the UK and the Gulf States including the field of energy production and use. We consider that there is a considerable mutual advantage in maintaining constant contact and urge the government to take every appropriate opportunity."

I think that answers the point you were making as to our attitude and

that's an official document I have brought with me from the House of Commons.

Question: I've been trying to get the floor for some time to challenge our speakers and the conference on something that I think is being forgotten. We've heard from every speaker in every instance that oil and gas is scarce; it is finite; we speak in 95% of our discussions about fossil fuel as energy. It seems to be that we should forget about fossil fuel, let the oil companies worry about it, let them develop it, and then get on with the real problem. Let me give an example: In the horse and buggy days we had transportation, we made the wheel rounded, we greased the wheel, we picked up the waste more efficiently, but we didn't accomplish much until we went to the automobile. We're in the horse and buggy days with our fossil fuels; we've got to get on with other energy. Now I would like to challenge our conference and our speaker about how we're going to get on with this—what are we doing—and let's spend 95% of our time talking about valuable things, the future, and 5% on oil and gas. Mr. Brown, do you see your country and does our representative from Japan see his country as cooperating money-wise and sending your best scientists, a world consortium, let's say, of getting on with finding a new source of energy, using the oil and gas and coal where they should be used and not burning them. How do you see this, and would each speaker think of this in the future, and how do we get on with really involving ourselves in energy of which there's plenty if we know how to garner it?

Brown: Well, I can only say that speaking for myself and not my friend from Japan; I thought that's what I'd spelled out in my speech, but then, like Mr. Parsky, perhaps I didn't do it very well. What I was explaining as a preliminary and why I talked about oil in the final part of my paper rather than the first part of the paper was because I regarded the first part that much more important than oil. That is to say I struggled to find alternative resources. My country for an example since you ask me a direct question, so I must be a bit chauvinistic, my country has a greater proportion of its energy provided by nuclear power than you do. We are searching very hard, my own committee upon which I serve is sitting there while I am here, carrying on the good work, taking public evidence on the possible uses for solar energy, geothermal energy, and windpower. We have 15 sites identified in the south of England where they're putting up windmills to see if they could conceivably contribute. Personally, I don't think they can, because we've looked at it many many times before. If I may say so, I used to look at these problems from the vantage point that you have, as an academic where I was resposible for nothing and I could say anything I liked, and I used to enjoy myself, as you are no doubt enjoying yourself, leaving others to find the problems and to solve them. I used to find the problems; they had to solve them; and all I can tell you is certainly my country is seized of the argument that we have got to conserve energy. We're seized of the argument that we've got to find alternative sources of energy. We are very uptight over the pollution of the atmosphere. We are running conservation lobbies, not so well as you run them, not so sophisticated, but with it in our hearts just as you have it in your hearts to stop people polluting the air, the sea, and all those other things which are now subjected to pollution. I, for example, objected most strongly to your Boeing 747, coming in every 3 or 4 minutes over my head, deafening me, but then I was a good American friend, I didn't stop them landing. We could have mounted the same sort of campaign, if I may say so, as your academics and eggheads are mounting in Washington. In exactly the same way we could have had a confrontation but we didn't, because we recognized that the movement of people is one of the best possible securities of peace in the future; stop me coming to America, stop you coming to England, because we can't get there, and we would be back where we started, isolated from each other. So I took the bigger view, the long view, that whilst the noise may have hurt me for a couple of seconds, the value to society was so much greater. I trust that your country will take the same view on Concorde and let it land in exactly the same way as we, so many years ago, took the decision in your favor in order that you could have a better standard of living provided by the airline companies in your country. And so I say, we're going at it as hard as we can in all the

fields to provide alternative benefits.

Question: As the gentleman from Minnesota, my question would be directed to all of the people who spoke today, and I wish that all of these people spoke in a panel. But you may answer the part of the question you can. Following the war in the Middle East in 1973 and the Arab Oil Embargo, there have been reports in the West regarding a joint venture of the industrialized Western nations to occupy the oil fields of the Middle East in case of another embargo. In your opinion how likely is it that a new embargo will take place and how seriously should these reports be taken?

Brown: I am not sure I've got that quite right. Do you mean battle between the Israeli and Arab states, is that what you're talking about?

Question: Yes.

Brown: I can only hope, I am not entering into the fight, because I have friends on both sides. Let me say this, the Israelis and Arabs can fight it out as much as they like, but I thought we were moving away from a society where we thought problems could be resolved by force of arms, by killing, by death; I thought we had moved a long way from that; I thought that's what the United Nations was for (I thought we were building a new Jerusalem), and what staggers me is that any young man, like yourself, should feel that such a question ought to be put. Shouldn't the question be, how much can you do, Mr. Speaker, how much can I do, how much can the person asking the question do, to ensure that people never again go fighting each other, killing each other, innocent men and women, simply to obtain some objective that ought to be able to be obtained by simple process of dialogue, discussion, and in the end ordinary common and good sense?

Question: Mr. Brown, I happen to come from Cyprus and I am a victim of aggression and I think that my question was very well placed and I still expect an answer.

Brown: I rather suspected you came from Cyprus. I heard you yesterday; I thought I would tell that to you, because when you say you were the victim of aggression, the other side to whichever you are referring also claims they were victims of aggression. The sadness was that you killed each other, and that never made us in Britain very happy at all, and when we attempted to be human, to provide places for women and children to take shelter, we were kicked by both sides, your side, whichever side, that is, plus the other side. I say to you, brother—I repeat—if we're going to go through life arguing that we can fight each other in that way, then it's a very, very sad country, and we're speaking in a marvelous place of excellence, and one can only draw the conclusion from that, that education doesn't seem to be doing us any good at all.

Developing, Oil-Importing Nations' Perspective

The Honorable Abdul Majid Mufti
Economic Minister, Embassy of Pakistan, Washington, D.C.

I am grateful to the President of The University of Texas and other sponsors of this International Ex-Students' Conference on Energy for inviting me to address this distinguished gathering about the perspective of developing oil-importing nations. As most of these nations have also been categorized by the United Nations as "Most Seriously Affected" (MSA), I would like to begin by reviewing the impact of recent international economic developments in general and the so-called energy crisis in particular on their social and economic situation.

As you are aware, one billion people in the MSA countries are struggling to improve their miserably low standard of living. The annual average rate of growth of their Gross Domestic Product during 1970–75 has been insignificant and amounts to about one dollar per annum on a per capita basis.

The current recession in industrialized countries has worsened their plight by not only retarding the volume of their exports but also appreciably lowering their prices. During 1970–75, volume of exports of the world as a whole increased at the rate of 5.6 per cent annually, while the comparable figure for MSA countries is 1.9 per cent only. It is thus clear that this has been a period of virtual stagnation in the exports of MSA countries.

While the annual average rate of growth in the GDP of MSA countries during this period has been only 3.3 per cent, the average annual rate of growth in their volume of imports has been about 6 per cent. It is thus clear that the process of adjustment for these countries has indeed become extremely painful, as they have experienced a double squeeze:

(a) their export earnings have gone down, primarily owing to international recession in the developed countries; and

(b) their imports have gone up, owing to the increase in the prices of energy and non-energy imports.

We might justifiably ask what are the implications of these developments for the balance of payments of these countries. Current account deficit of these countries has increased from $1.6 billion in 1970 to $12.7 billion in 1975, an annual average increase of 51 per cent. On the other hand, Development Assistance Committee (DAC) flows have been rather modest. In 1970, these flows more than covered the deficit on current account. However, in 1975, they covered only 33 per cent of this deficit. OPEC countries have stepped in by committing about $22.5 billion and disbursed additional concessional assistance of about $7 billion. This has ameliorated the situation somewhat, but the MSA countries had no option but to resort to alternative sources of financing which included short-term borrowing on much harder terms to meet their current account deficits. It is hardly necessary to emphasize that they had no alternative but to resort to this course of action as they could not afford to sacrifice their growth rates. In fact, it could be argued that there is rarely a choice between running deficits in the balance of payments and protection of growth rates. Any meaningful and politically acceptable strategy of development must take into account the aspirations of the people to improve their standard of living and quality of life, even at the expense of deficits in their balance of payments. The current standards of living of MSA countries are so low that the so-called tightening of the belt can make only marginal impact on the fundamental causes of underdevelopment. Are we not familiar with the rather common phenomenon in developing countries where poverty-ridden families have to often borrow even to sustain life? Preservation of life is instinctive and lends itself to no compromises.

There is fortunately an increased realization that the situation has become intolerable and cannot last without a serious disruption of the existing economic order. Debt service payments have increased to such an extent that it may not be possible for MSA countries to borrow in the future. You will recall that the annual debt service payments have already increased from $2 billion in 1973 to $2.7 billion in 1975. The debt service ratio in MSA countries in 1975 was about 17 per cent. Even if these countries are able to attain an annual growth rate of 6 per cent in their GDPs during 1975–80, the debt service ratio is expected to rise to 29 per cent. You will agree that this is a dangerous and most undesirable development.

It would be pointless at this stage to get involved in the controversy whether the price of oil now reflects its true scarcity value or whether the five-fold increase in the price of oil was indeed the most important single cause of the current recession. Much has already been said on both sides and the controversy is not likely to be resolved. I would also like to avoid being entangled in the debate whether the OPEC countries have played their due role in ameliorating the lot of the MSA countries vis-a-vis Organization for Economic Cooperation and Development (OECD) countries, as much has been said on both sides. It would suffice to state that there is a growing awareness among the OPEC countries that with the spectacular increase in the price of oil and other imports of critical importance to MSA countries, their economic and social development has become infinitely more difficult. The so-called Fourth World, therefore, finds itself in a dilemma of unprecedented magnitude.

I have already pointed out that the increase in the per capita income in MSA countries during 1970–75 was only one dollar per annum, i.e., at the rate of 0.9 per cent. If per capita incomes of these countries are to grow even at 2.3 per cent in 1975–80—a rate which is lower than the modest target of 3.7 per cent set for the Second Development Decade—the deficit in their current account is estimated to increase from $13 billion to $27.9 billion by 1980. This estimate of the deficit is based on the assumption that official development assistance will rise to 0.7 per cent of the GNP of OECD countries. However, if this assumption does not materialize, the deficit would be proportionately larger.

The question that stares us in the face is how will the MSA countries finance deficits of this magnitude when their debt problem has already reached alarming proportions? Clearly the steps taken by the international community so far—the creation of Oil Facility, enlargement of the Compensatory Financing Facility of the International Monetary Fund, and OPEC assistance—are, in this overall context, mere palliatives and obviously cannot solve even the short-term problems.

It is indeed the responsibility of the international community to help the MSA countries and other oil-importing developing countries to overcome their short-term balance of payments problems to protect their growth rates. It is also the responsibility of the international community to help in the structural changes which must be brought about in the longer run to ensure a steady improvement in the standard of living and quality of life of the peoples of these countries. In the short run, adequate transfer of capital would be required to meet their current account deficits. In the longer run, policies will have to be designed to enable oil-importing developing countries to increase their exports, substitute their imports, and change their consumption patterns by provision of greater access on equitable terms to the markets of the developed countries for the exports of these countries. This will have to be synchronized with the transfer of appropriate technology to enable MSA countries to harness their human and natural resources.

Let us remember that the world setting for economic assistance has undergone a fundamental change in recent years. Power is no longer concentrated in the hands of a few nations. Global economic interrelationships have been sharpened by the abrupt movement of world commodity prices, the rapid spread of depressed levels of economic activity, and a world-wide inflationary pressure. We are confronted with an enormously complex situation where more knowledge and greater understanding are needed. But do we have the necessary wisdom to grapple with the potential forces of tension and discord? As the world situation is so fluid, there is a fresh opportunity for the pursuit of peace and justice, for creative solutions to co-existence on a global scale, and for working out among countries new codes of mutual relations.

There is a strong belief in the developing countries that the future progress requires important changes in their relationships with the developed countries. Arguments for reshaping the international economic order are being put forward with increasing conviction and frequency. It seems unlikely that the developed countries will ignore or sidetrack this widespread clamour for a new economic order based on equity and justice. Let us not forget that the developed world also relies on the developing countries for raw materials, for markets for its manufactured goods, for mutually beneficial investment opportunities, and for political cooperation.

The Government and people of Pakistan have viewed the current situation with circumspection and have all along put forth constructive and conciliatory proposals at various international forums. My Government has recently proposed in the Paris Meeting of the Finance Commission that the international community should immediately consider international action to provide immediate and effective debt relief in respect to the public debt of MSA countries. It has also been proposed that the resources of the Trust Fund in the International Monetary Fund should be substantially augmented by voluntary national contributions. Once again, the attention of all member countries of DAC has been drawn to the rather modest target of 0.7 per cent for official development assistance (ODA). It has also been suggested that the grant element as a proportion of the total ODA should rise significantly. Pakistan is also in favour of a substantial increase in the Fifth Replenishment of International Development Association (IDA) and enhanced contributions to the Third Window of the World Bank. It is also felt that contributions to soft loan windows of regional banks should be increased, and further steps should be taken to augment subsidies without interest on funds borrowed on commercial terms by MSA countries, both on bilateral and multilateral bases. My Government has also suggested that the contributions to the United Nations Special Fund should be expedited and augmented.

While these suggestions would help MSA countries to overcome their short-term balance of payments difficulties and protect their growth rates, they would obviously not suffice in the longer run. New initiatives are, therefore, required to facilitate the structural transformation. According to the latest reports, the U.S. Government is likely to come up with some important suggestions such as creation of a new Natural Resources Bank with the support of the private sector from the developed market economy countries at the UNCTAD-IV Conference at Nairobi. The developed world should formulate and implement policies to facilitate the flow of not only capital but also technical and managerial skills to enable the poor countries to develop their human and industrial resources. This should be supplemented by policies designed to ensure

stable markets for their exports. The present terms of international trade should be reviewed and where inequities exist they should be removed.

While the international community must cooperate in the establishment of a new economic order, the developing countries must also realize their responsibility. There should be a better understanding of the limitations of foreign aid. Prestige projects should be avoided "as bad economics does not make good politics." Enlightened planners in developing countries are now seeking to avoid the path of imitative growth. Development goals are being adapted to individual country situations, historical traditions, and cultural values. There is also a growing realization that the development process should have as its bedrock the principles of self-reliance and self-help if political sovereignty is to become meaningful.

My country is painfully aware of the global energy situation. The global energy consumption picture is essentially unbalanced, as the share of the developing countries stood at 8 per cent only in 1970, although 40 per cent of the world population resided in those countries. Per capita energy consumption in the developing countries in the same year was 330 kilograms of coal equivalent as against 5914 kilograms of coal equivalent in the developed countries. This disparity is even more pronounced in electricity consumption, with the developed market economies accounting for 71 per cent while the more populous developing countries consume a mere 7 per cent.

As energy is a critical factor in the development of any country, Pakistan has undertaken a systematic programme of indigenous energy development. Exploitation of existing oil fields has been accelerated. Pakistan is endowed with a very large sedimentary basin. The existence of a number of oil and gas seeps has encouraged us to believe that the country has a rich potential. According to a team of Canadian consultants, the recoverable potential of oil in Pakistan is 36 billion barrels. A view has been expressed that an oil exploration programme which would provide for the drilling of 600 exploratory wells spread over a period of 15 years could lead to the discovery of half of this potential. The exploratory efforts have been inadequate as only 90 exploratory wells have been drilled so far, giving an average of about three wells per year, in spite of the fact that the success ratio has been 1:6.

Pakistan has offered attractive and generous terms to foreign investors from friendly countries for exploration and exploitation of its vast hydro-carbon resources. Our Government is ready to participate even in the pre-exploration stage. The oil companies are allowed to retain majority interest after commercial discoveries, and the expenditure incurred prior to such discoveries will be reimbursed in proportion to the interest acquired by the Government after actual discoveries. Royalty payments are allowed as credit towards income tax. It has been decided that royalty shall be charged at a fixed rate of 12½ per cent of well-head value and not on a sliding scale with increased production. Taxes on income shall not exceed 55 per cent of the profits before deductions of payments to the Government. Income tax is charged at a rate between 50–55 per cent inclusive of royalty.

To provide further incentives, oil companies holding a petroleum licence or mining lease are allowed to export their share of petroleum. The sale proceeds from such exports are allowed to be retained abroad. Import duty on machinery and equipment brought into the country for oil exploration is levied at a consolidated concessional rate of 5¼ per cent ad valorem. In the case of off-shore drilling, no import duty and sale taxes are applicable. My Government is also prepared to enter into production-sharing agreements if so desired by foreign oil companies. It is thus clear that Pakistan is keen to invite the oil and gas companies and investment corporations to take advantage of the generous terms being offered to them for exploration and exploitation of energy resources in the country.

The gas network in Pakistan is also being expanded in order to reduce the use of oil, the bulk of which is being imported. The gas pipeline system is being expanded and two projects of $100 million each are being implemented. The areas which cannot be reached economically are proposed to be served by air-mix liquified petroleum gas plants (LPG plants). It is expected that the use of LPG will save twice the amount of kerosene oil.

Electric generation and transmission is also receiving attention and support. Emphasis is being placed on accelerating development of hydro-electric power and building up extra high voltage lines, including 500 KV. This is expected to facilitate inter-area transfer of power.

Coal resources are also being augmented. A thermal station of 250 MW based on local coal is being commissioned. The capacity of this power station will be ultimately raised to 1000 MW.

So much for the development of indigenous energy resources. Pakistan, like most other MSA countries, has also experienced the double squeeze of rising imports and falling exports. To maintain the momentum of development, we have had to rely to a greater degree on an inflow of foreign resources. We also had to borrow short on near commercial terms to pay for the rising import bill of energy and non-energy items. Our problems have been compounded by poor weather in the form of alternating floods and droughts. However, there has been a marked improvement in the economic situation during the current fiscal year (1975–76). Despite subdued recovery of market economies from recession and a 20 per cent loss of our cotton crop owing to an unprecedented pest attack, the GDP is expected to grow at 5 per cent. Pakistan has also repaid some short-term credits and reduced the annual inflow of non-project assistance. Investment and savings have been stepped up and inflation has been brought under control. We are now confidently looking forward to the next year and we are expecting the GDP to grow at 8 per cent.

In agriculture, we are expecting 12 per cent growth in major crops owing to a greater availability of water from the Tarbela Dam and an increase in fertilizer consumption. In the industrial sector, substantial allocation is being provided for yarn, cloth, and sugar. Increased investment outlays are also planned for the public sector. A million-ton steel mill is under construction and a number of new fertilizer plants will be in operation by 1980. The investment programme for the next year has been drawn up within the framework of a medium term plan. It is expected that capital formation will increase to 18 per cent of GDP and will continue at this level for the next five or six years. During the medium-term, it is also expected that certain structural changes would take place which would enable Pakistan to increase its exports, adopt a rational policy of import substitution, and make fuller use of available technology to improve the quality of life of its people. Policies are also being designed to control the growth of population.

I hope I have been able to give you some idea of the problems being faced by the poorest amongst developing countries. The implications for the international community are self-evident. In the short run, adequate concessional assistance will have to be provided to enable these countries to tide over their immediate balance-of-payments problems so that they are not forced to curtail their growth rates. In the longer run, greater access to the markets of the developed countries will have to be provided to enable these countries to earn sufficient foreign exchange to pay for their rising import bill.

The establishment of the new economic order should obviously not be viewed in terms of confrontation. It should be well understood that future economic advance presupposes meaningful collaboration in this progressively interdependent world. There are no separate futures for the rich and poor. It is no longer possible to tolerate economic and social inequality at the international level without seriously damaging the entire fabric of modern civilization and leaving a legacy of conflict and tension for the coming generations. Let us, therefore, surge forth, hand in hand, in a spirit of cooperation and accommodation so that the resources of this earth are exploited to the maximum for the improvement of the standard of living and quality of life everywhere.

Thank you.

Discussion

Question: I have the intention this time of taking advantage of the opportunity again to do a commercial for the OPEC countries. Within OPEC we have been giving a great deal of thought to this situation of the developing countries which do not have the materials, the strategic materials that we do have, which is oil, and we have been looking into that; we are discussing the matter, and many things have been done by the OPEC side to help that situation. So then again as the speaker very well knows that foreign aid is not sufficient; it's not enough. So we have to do something else besides that, and I believe he's right in asking us to do something else, at this time. That's why the OPEC countries have already taken it upon themselves to go to that conference over in Paris to talk to the U.S.A., to France, to other industrialized countries around the table there and also to the developing countries which are members of that conference. So, I didn't mean to ask a question, because he has already explained exactly what the situation is. All I want to say is, yes, we are ready to do something and that I really concur with you in telling this distinguished audience that the time has come to really do something now, because otherwise we are going to have a real bad situation.

Kozmetsky: I would like to follow up. I am sure if we carried on with the discussion that our Secretary of the Treasury had yesterday with you, it's quite important that certain projects be started, and I would be very interested in your thinking of what priority of projects would you like either from OPEC as well as the developed countries. Let's not worry about where it comes from as we walk hand in hand in cooperation; what are the things you would like to see done?

Mufti: I did say in my paper that while I am trying to plead for assistance to the underdeveloped, I do not by any means suggest or imply that there is not a lot to be done by the developing countries themselves. Now, if one were to go into the historical causes of backwardness, again we would be lost in a debate. Some people maintain it was because of the colonial past of these countries, and let me hasten to explain that when I talk of colonial past, the record of the U.S. is very clean and you don't have anything to worry about that. But there are other countries, without mentioning them, it's not only my country which was subjected to the British rule, but the whole lot of them, the French rule, the Dutch rule, and colonialism anywhere is not a benevolent thing. In fact you had some experience of it yourself in this country when you started with no taxation without representation, etc. So I am saying that the result of this historical past is that basically the physical infrastructure for mounting a reasonable development program doesn't exist in many of these countries, including mine. By physical infrastructure of course we mean the means of transport, we mean power, we mean irrigation water, we may even include the capacity to manufacture agricultural machinery which can raise agricultural production. These days, agriculture is no longer an age-old profession followed in a primitive way. Your great country is the best example; you have converted agriculture into technology, and believe me, I am one of the greatest admirers of what has been done in the U.S. of America. And today my colleague, Mr. Tariki, mentioned the need to invest the surplus money in agricultural resources of other Arab lands. In my country, for example, we have fertile land, about 35 million acres of irrigated land, which is as big as the whole state of New York. That is the size of our irrigated land, but our yield per acre is so low because we don't use good seed, we don't use chemical fertilizers, we use them in very inadequate ways. For example, Pakistan uses fertilizer at the rate of 20 lbs. to an acre; in the U.S. it is 1000 to 1200 lbs. to an acre. So these are the areas in which we can work, but I would come to a very difficult area, because you ask a very difficult question. In determining priorities in a society which is suffering from scarcity, it becomes very difficult to determine whether you invest in projects which will lead to greater growth or to more equal distribution of income, because when you try to invest in growth, what happens is you develop two extremes, the rich become richer, and the poor, if they do not become poorer, do not become rich enough not to feel jealous. So there is tension built into this society. So I've tried to answer your question the best I could, but it needs a separate debate.

Kozmetsky: I was very much impressed when I studied your country, it was during the colonial period that you did have 90,000 miles of irrigation ditches, one of the finest irrigation systems in the world. Also, under colonialism the British put in one of the finest higher education systems that they understood at that time, the finest schools of law, history, and government. Now in our country because of the sad war between the states and shortly after the death of President Lincoln we started the Land Grant University, and I had often wondered what would have happened in Pakistan if they had started the Agriculture University, the traditional enemy of UT called Texas A&M. So education is generally needed. Now how does one evolve from that. Just to educate the people is not enough, because most people today when they get educated- now this is my question—do they want to go into agriculture or do they want to join the rich?

Mufti: Once again, I thank you for this question. This again you have very rightly pointed out we need to invest our good manpower into agriculture, into rural development where the majority of the people live. We are doing a great deal in this regard; I might just throw in some figures. When the British were in Pakistan, for example, we used to grow about two million tons of wheat; today we grow eight million tons of wheat. When the British were there, we used to grow about one million bales of cotton; today we grow about four million bales of cotton. So all this, I could give many figures to illustrate that we have tried to improve. But on the other hand, on the manpower training side, true, I would like to give credit to the British for setting up colleges. The situation is not too good. When they left you would not believe that the rate of literacy was 7%; only 7 out of 100 could read and write. So we have to go a long way, not only to make them literate, but to make them vocationally and professionally useful to society. And again, another small point, the British developed the country, there's no question. I would admit that anytime. But they developed it from a certain angle, and the angle was to send the irreplaceable raw materials to England, so the system of transportation pointed in their direction, and some of the things we have done, we have tried to correct the situation. For example, I mentioned there were one million bales of cotton grown in the country, but there were not more than 1,000 spindles functioning in Pakistan when they left. Today there are four million spindles of cotton, there are 40,000 looms, weaving class, and we have become one of the big exporters of textiles in the world. I am sorry to say that perhaps Manchester and Lancaster have closed down because of us and the Indians and Brazilians, so this is the situation.

Kozmetsky: Well, now we have the first concrete project for our friends from the OPEC countries, and I happen to know the OPEC countries are very interested in textiles, not from the natural fibers, but from the synthetic fibers. They have an overabundance of technological talent, people, and equipment in Pakistan; they'll be very happy to help you open plants in your own country.

Mufti: And natural gas, they have natural gas in Texas.

Kozmetsky: I've been working on bringing the synthetic fibers to Texas and away from North Carolina because we have also the largest amount of synthetic fibers after natural cotton and wool in the U.S. here and no textile industry. Let's keep the natural gas in Pakistan, let's not be so generous.

Mufti: I might mention here in favor of OPEC countries that they are already investing in some of the very good projects like fertilizers, like some of the livestock developing projects.

Kozmetsky: The other thing I have found and I am going to ask my friend, Dr. Woodson, to comment on this, and I am actually putting him on a terrible spot because in the 5 or 6 years I think he thought I was his friend, I've never discussed this area with him. Most people on campus don't realize in a Graduate School of Business we do have a number of scientists and technologists, and one of the problems we have been working on for quite some time, about 8 years now, is why must technology and agriculture always be fertilizers and pesticides? A number of us have been involved in all the high technologies and so we have been bringing the other technologies into this area. We have a number

of stories to tell on that, but Dr. Woodson, why isn't it possible, that you who are so involved in high technology, who are working on energy and especially the prime resources for the 21st century give us a spin off for agriculture out of technology in the next year or two, and if you can't tell them any answer to that, I will.

Woodson: Well, I guess the only comment I would make on that is that it's my understanding that rather than making pesticides and herbicides we really ought to do some genetic research and develop plants that are resistant to the bugs so that we don't need to do all that kind of thing. And I feel that that kind of technology will develop and will benefit mankind in the future.

Kozmetsky: Well, one of the ones we've been working on is very cheap, fairly simple. When we were working on the space program of putting men on the moon, we first found out we never could tell anyone what a normal environment was for a human being even on planet earth, so we knew we had to protect him against the hostile environment, both in space and on the moon. And in order to do that, a new plastic had to be developed, and so one of the first applications we worked on was just simply using plastics as an environment to grow food in. I shall never forget my first trip to Japan. We were trying to get the various agriculture interests in Arkansas, Governor Rockefeller at that time, and a number of very important families in Texas, and they didn't believe us professors. But when I got to Japan, I saw it everywhere I went, and I think the crop that impressed me at that time was strawberries; they get 4 crops of strawberries grown under the shelter, simple plastic. So there is much technology that can be brought to these areas. The other ones that might interest you is—this came after our visit to Switzerland—we find that the average Swiss income could be gained off of simply taking care of two acres of vineyards. I tried to talk my wife into buying four acres so I could keep on retiring and still have an average income. She refused; she's a person in her own right she reminds me. We found we could do it in Texas— let us tell this audience some very interesting things. We discovered that the wine industry in the U.S got started in Texas; the Spanish brought the vines, and planted them in Corpus Christi. When they wanted to have the wine industry in California, the vines were taken from Texas to California, and when France had its trouble they were taken from California back to France. Now we wondered what happened to the wine industry in Texas. A blight hit our vineyards in 1926 so everyone agreed it could not be done. Today there are three wineries in Texas, about 50 vineyards being started by marketing majors in the College of Business. Now this is the sort of thing my friend from Pakistan is trying to tell the developed nations, these are some of the things he wants the help of OPEC. These are some of the things we can do as we walk hand in hand in the spirit of cooperation, as we drop the old mechanisms of distributing natural resources through war and grief. I do want to thank you for being utterly frank in your paper, and I do want to, as you said, end on a note of optimism.

Energy Politics in Eastern Europe: Structural Changes in Production and Consumption and Resource Dependence

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The rapid economic growth and especially the requirements of industrial technology in the socialist countries of Eastern Europe[1] (population 130 million) during the last 30 years placed great demands on available fuels (solid fuels of bituminous coal and low calorific lignites are the main commodities available in larger amounts). Thus these countries are more and more dependent upon imported fuels, especially crude oil and natural gas. Consumption of oil in the six European Council of Mutual Economic Assistance (CMEA) countries increased from 16 million tons in 1960 to roughly 79 million in 1974 and that of natural gas from 13 billion cubic meters to approximately 58 billion.[2] Albania and Yugoslavia also show a rapid growth in their oil and gas consumption. The deficit for the six CMEA countries was largely made up by imports from the Soviet Union. Twenty-four percent or 6.4 million tons net of all Soviet crude oil and petroleum product exports went to these six countries in 1960, 32 percent in 1970, 51 percent or 59 million tons in 1974, and over 55 per cent or 72 million tons in 1975.[3] In spite of these Soviet imports, the East European countries, with the exception of Romania (the largest crude oil producer now having reached its maximum), have only slowly reduced the role of solid fuel—"in the late Sixties oil and gas constituted only 21 percent of their energy consumption (excluding Romania the share was 13 percent),"[4] by 1974 the corresponding figures were 33.5 and 27.3 percent respectively. The high priority given to accelerated growth in the so-called "leading sectors," e.g., petrochemical and synthetic material industries, electronic industries and modernization of transport, and the emphasis on the introduction of advanced technologies, have forced these East European countries to rely to an ever-increasing extent on imports, especially petroleum and natural gas, as well as many of the key minerals.

Following the pattern established in the 1960's in

Western Europe, the main burden of energy demand in the East European countries shifted from solid fuels—roughly 96 percent of the energy demand in 1960 in the three northern East European CMEA countries and 80 percent in the others, as against 70 percent for Western Europe and 70 percent for the Soviet Union—to hydrocarbon fuels which in 1974 supplied close to 34 percent of the total energy mix of the East European CMEA countries as against 72 percent in Western Europe and 63 in the Soviet Union. In the more industrialized countries of East Germany, Czechoslovakia, and Poland, the share of oil and natural gas varied from 16 to 9 percent, thus reducing the overall reliance on coal as the main source of fuels. By the mid-1970's the energy mix had thus radically shifted to a reliance on coal of roughly 66 percent for Eastern Europe as a whole, but only of 24 for Western Europe and 32 for the Soviet Union. One-third of East Europe's increase in oil and gas consumption was met by natural gas imported from the Soviet Union, which by the end of the 1960's accounted for one-sixth of the total energy needs of the countries of Eastern Europe (excluding Yugoslavia). The increased petroleum needs until 1975 were generally met by the U.S.S.R. "since imports from Third World countries were almost entirely compensated for by exports of refined products to the West."[5] In 1974 consumption of primary sources of energy in the East European countries was distributed 66 percent in solid fuels, 19 percent in oil, and 15 percent in natural gas (comparable figures for Western Europe were 24, 57, 15, and 4 percent in hydro and nuclear electricity).[6] It should also be noted that all the East European countries have completed or in mid-1970 are building nuclear power plants.

It is clear that the growing demands of the sophisticated modern economy in the East European countries brought about basic structural changes in the consumption of energy. The resulting needs cannot be satisfied from the limited domestic production. While the Soviet Union on the other hand has some of the world's largest energy and mineral reserves, it must be noted that many of these reserves are located in Siberia, in environmentally difficult accessible regions where exploitation and transport costs demand huge capital investments imposing an increasing burden on the whole Soviet as well as European CMEA economy.[7] It is clear, as has been stated before, that the Soviet economy must balance East Europe's needs, the Soviet domestic commitment, and the comparative advantage of Soviet oil and natural gas on the world market.[8] Without doubt the supply problem of the East European countries is as serious as for the West European countries. From the earliest postwar period the European CMEA member countries have relied on the Soviet Union as the main deficiency supplier of all oil and natural gas. Indigenous supplies of the East European CMEA countries, with the exception of Romania, are less than 5 percent of all oil and 75 percent of all natural gas consumption.[9]

The basic questions of the energy self-sufficiency of the Soviet Union, with its highly favorable energy mix, the allocation in the Soviet fuel supply, the future role of Siberia's resources, questions related to the new Soviet pricing policies, as well as numerous other related questions, have been given attention in numerous recent publications.[10] The emphasis in the following pages will be directed to the distribution and changing supply problem of the energy economy of the six East European members of CMEA, as well as those of Yugoslavia and Albania. This will enable us to venture some thoughts on future fuel developments in the region, stressing the impact of the post-1973 policy of energy savings, the increased prices which all East European countries had to pay for Soviet supplies starting in 1975, the policy of increased diversification of imports of crude oil and petroleum products, thus reducing the East European countries' reliance on Soviet imports, and finally some concluding thoughts on the political-strategic aspects of the Soviet-East European relationship.[11]

The Energy Situation

The structural changes in energy production and consumption have been rapid since the mid-1960's. The annual increase in petroleum consumption between 1961 and 1971 averaged 9.3 percent (total energy consumption growth was 4 percent). Due to the fact that this process began later than in the West European countries, petroleum and natural gas show considerably greater growth rates than those of solid fuels. In spite of this change, coal was still the dominant fuel in the consumption of most East European countries as can be seen in Table 1 for 1974. Although the use of home-produced coal and lignite for energy has been re-

TABLE 1
Production and Consumption of Primary Energy in 1974 (In Percent)

	Total Million Metric Tons Coal-Equivalent	Coal (hard)	Lignite and (Brown)	Crude Oil	Natural Gas	Primary Electric Energy[a]
Production						
Albania	4.0	0.0	10.6	80.7	5.0	3.7
Bulgaria	13.1	2.0	91.7	1.6	1.8	2.9
Czechoslovakia	79.5	37.0	60.4	0.3	1.6	0.7
German Democratic Republic	85.8	0.8	86.6	0.1	12.0	0.5
Hungary	24.3	10.0	48.8	13.2	28.0	0.0
Poland	182.8	89.1	6.1	0.5	4.2	0.1
Romania	76.9	6.8	10.9	28.5	52.3	1.5
Yugoslavia	26.7	49.5	14.6	19.2	7.2	9.5
USSR	1533.0	27.8[b]	4.4	44.0	22.6	1.2
Eastern Europe (excl. Yugoslavia)	431.9	43.6	35.1	6.4	14.3	0.6
Consumption						
Albania	1.7	NA	25.6 NA	57.7	11.4	5.3
Bulgaria	36.4	9.6	41.5	45.8	0.7	2.4
Czechoslovakia	100.2	28.7	47.4	17.2	5.6	1.1
German Democratic Republic	119.2	6.6	64.0	17.1	11.8	0.5
Hungary	37.2	13.3	32.4	33.8	18.9	1.6
Poland	157.9	77.1	6.5	9.7	6.6	0.1
Romania	74.5	13.0	8.9	21.4	53.6	1.1
Yugoslavia	39.8	6.3	42.3	40.1	4.8	6.5
USSR	1323.7	30.7[d]	36.8[c] 6.1	37.0	26.0	1.2[e]
Eastern Europe (excl. Yugoslavia)	527.1	34.1	65.7[c] 31.6	18.8	14.7	0.8

a Excluding peat, shale, and firewood
b 1975 coal production amounted to 490 million tons (less than the USA). See Theodore Shabad, "News Notes," *Soviet Geography: Review and Translations* (May, 1975), p. 33–7.
c The breakdown between coal and lignite for 1974 is an estimate.
d Four-fifths of all Soviet energy is consumed in the European USSR, incl. the Urals and Caucasus.
e Hydroelectricity contributed to total energy supplies about 3% in the European part and under 1/10 for the whole of the Asiatic part of the USSR. In 1975 Soviet nuclear capacity reached 5.7 million kw, 2.5% of all installed generating capacity (less than 1/5 of American reactors). See Theodore Shabad, "News Notes," *Soviet Geography: Review and Translations* (February, 1976), pp. 136–7.

Sources: United Nations, *World Energy Supplies 1950–1974*, New York, 1976
CIA, *Handbook of Economic Statistics, 1975*, pp. 76, 79–81
United Nations, *Statistical Yearbook, 1974*, New York, 1975, p. 362
United Nations, *Annual Bulletin of General Energy Statistics for Europe 1973*, New York, 1975
Leslie Dienes, "Energy Self-Sufficiency in the Soviet Union," *Current History*, Vol. 69, No. 407, August, 1975, p. 11; also "Energy Policy Changes and Prospects in East Central Europe," (unpublished paper, March, 1976), p. 3, Appendix

duced, it remains by far the largest source of primary energy for Czechoslovakia, Poland, East Germany, and Bulgaria—76, 84, 71, and 51 percent in 1974. The following discussions will detail the energy situation in the individual East European countries which will enable us to draw conclusions as to the supply problems and possible future developments, including East Europe's trade in crude oil and petroleum products (for details see Table 1 and Figures 1 and 2).

Romania with its petroleum and natural gas reserves was once a major exporter of crude oil. In spite of constantly expanding drilling areas, e.g., offshore in the Black Sea, and with some of the world's deepest wells,[12] increased supplies of indigenous production have not kept up with needs, making an ever-increasing amount of imports necessary. Imports from Iran, Saudi Arabia, Libya, Algeria, and Venezuela are estimated to have reached 6 million tons in 1975, leaving "adverse effects upon her economy when world prices soared."[13] Important developments have taken place at Ploiesti and along the eastern and southern flanks of the Carpathian mountains (Oltenia, Ploiesti, and western Moldavia, and in some parts of the middle and lower Danubian Plain). These developments have laid the basis for the growth of important oil refining and petro-chemical industries. Due to the possibility of pollution at coastal sites along the growing tourist areas on the Black Sea, refining of imported oil is now done inland, close to the Oltenian oil fields and the chemical plants of Craiova. Oil pipelines between the port of Constanta and Pitesti located on the southern slopes of the Carpathian (Transylvanian) Alps make this operation possible.

Important natural gas deposits make Romania's energy picture a much brighter one. Natural gas deposits rank second in Europe in size with the main location in the central part of Transylvania, Oltenia, and Muntenia. Gas first replaced oil for fuel purposes, but due to the energy crisis, power stations utilize more and more lignite, and thus additional gas can be made available to the rapidly growing chemical industry. Gas in 1974 accounts for more than half of Romania's energy consumption. Romania's coal production, especially its abundant available lignite, has been greatly increased to avoid the necessity of sizeable fuel imports. Much of this production is located in Oltenia and is expected to produce by 1980 over 70 percent of the country's coal production. Some hard coal (anthracite) is located in the Jiu Valley and lignite is widely distributed. The recent accelerated development of Romania's considerable hydroelectric potential, including the joint development with Yugoslavia of the Iron Gate hydropower dam on the Danube, has increased hydropower production and has provided the country on the whole with sufficient energy production. A joint project is under way with Bulgaria between Nikopol and Turnu Magurele, and discussions with Yugoslavia for further exploitation of the Danube for the development of hydroelectric power are under way. Some uranium discoveries near Bela Mare and Cluj were made in the 1960's, and an accelerated nuclear program, with the first nuclear plant to be commissioned in 1982, is now under way. Shale oil is being used to fuel a new 990 megawatt power plant at Oravita (Caras-Severin). Overall, Romania's indigenous fuel base offers a satisfactory base for self-sufficiency, making the country the only one of the CMEA countries independent of Soviet fuels.

Albania also satisfies its energy needs largely by domestically produced petroleum and a small production of natural gas. The older oil fields at Qyteti Stalin and the newer fields at Marineza Gorischte and Patosi are the main oil-producing areas of the country. An oil pipeline connects the port of Vlorë with the main refineries located at Qyteti Stalin, Cerrik, and Fieri. Roughly 83 percent of its energy needs are met from these resources alone. Natural gas fields are at Patosi and in the Devolli valley. Technical assistance by China has enabled Albania to exploit its rich hydropower resources. Lignite is plentiful (mostly in the Korcë valley), but anthracite and bituminous coal are nearly totally lacking.

Yugoslavia produces about one-fifth of its petroleum and natural gas needs in the Croatian-Slavonian fields and in the Banat. Rapid consumption of oil has forced the country to import increasing quantities from the Middle East with whom she has excellent relations. Oil refineries are located in the Sava Valley at Sisak, Bosanski Brod, and also at Novi Sad and Pančevo in the Vojvodina on the Danube. Most oil reserves are in eastern Slavonia. The construction of the new "Adria" oil pipeline from the northern end of the island of Krk to the mainland and on to Sisak will bring a connection with the previously built pipeline between Sisak and

Pančevo. The decision to build the Krk-mainland pipeline, concluded after many years of planning and searching for the necessary financing, will also make possible the much discussed branch line from Sisak to Hungary and into Czechoslovakia. This pipeline will ultimately have a through-flow capacity of 34 million tons of crude oil annually, of which 24 million tons will be available to Yugoslavia (capacity 20 million tons by 1980).

Natural gas is located to the north of the Sava River, but the sizeable lignite fields in the country could well serve as the basis for gas extraction. Such a plant has been completed recently in Kosovo and can produce 500 million cubic meters of coal gas per annum. The Kosovo energy complex, the largest in the country, is based on greatly increased coal production in the region. Sixty-eight percent of Yugoslavia's domestic energy needs are still satisfied by coal with lignite dominant (though generally of poor quality). The most important fields are located at Kosovo, Kolubara and Kostolac in Serbia, Kreka in Bosnia-Herzegovina, and Velenje in Slovenia. Bituminous and anthracite coal are extremely scarce. The production of hydropower has received considerable attention, and numerous plants have been built in the postwar period, though much potential is still unexploited. Included in these developments is the earlier mentioned Iron Gate hydroelectric plant between Orsava and Turnu-Severin with an output of 10 billion kwh which is shared equally between Yugoslavia and Romania. Discussions are now under way for a new Danube hydro powerplant between Guria and Radujevac. Recently an agreement was concluded with the Soviet Union for a natural gas supply linking Yugoslavia to the East-West gas transmission system originating from the new Orenburg fields.[14] Uranium is also mined in small quantities, and the recently discovered oil shale deposits at Aleksinac (Serbia) together with other smaller deposits could cover important energy needs. Mention should also be made that the national electricity grid system of Yugoslavia is now tied to the international energy system of the socialist countries, the "Mir Electricity Grid."

Bulgaria's energy needs for its expanding industries cannot be met by domestic production, and a large part of her petroleum needs must be imported, (10.5 million tons in 1974) mainly from the Soviet Union with smaller quantities coming from Egypt and Libya.[15] The small oil fields are located at Pleven and Gigen in the Danubian region. A large oil refinery has been erected on the coast at Burgas for imported Soviet oil. Considerable exploration activities are now centered on the Black Sea. Natural gas too is scarce with one small field at Vratsa. A pipeline is planned between the oil refinery at Burgas and the small oil field at Pleven. To facilitate imports from the Soviet Union, a gas pipeline has been built from the Soviet Union (Tiraspol to Vratsa).

Due to its energy shortage, Bulgaria gave early attention to the development of nuclear power and has taken the lead in its development among the East European CMEA countries.[16] Already in 1969 it began construction of a nuclear power plant at Kozlodoi near the Danube in an area lacking industrial development. Reports speak of a production in 1975 of 5.6 billion kwh of electricity. Recent reports estimate that in 1980, 25 percent of its electricity will be derived from nuclear power. Water from the Danube is processed after its use to be suitable for drinking water. It is clear that the success of the Bulgarian nuclear program serves as a model to the other socialist countries. It also should be pointed out that while Bulgaria is short of indigenous fuels, it has ample reserves of lignite. With the declining deposits in the Pernik basin, new deposits in the Eastern Maritsa basin (mostly open cast mining) assure the country of ample supplies for the future. Reports also indicate that the country's oil shale reserves would permit its exploitation with two processing plants now under consideration near the deposits. It should be noted that Kaiser Engineers International, according to a report in *World Oil* (August 15, 1975), has been retained to assist in the formulation of a development plan. Bulgaria's national electricity grid system is connected with the earlier mentioned "Mir Electricity Grid" of the socialist countries.

Hungary produces petroleum near Szeged (Algyoe fields), the country's most productive region (providing about half of her total hydrocarbon production and natural gas, mostly in the eastern Great Plain). Over 500 wells have been drilled and 300 miles of pipelines laid with a gas-processing plant put on stream. Domestic production contributes about 30 percent of its petroleum consumption, and most of the remainder is imported from the Soviet Union, a smaller amount

FIGURE 1
Eastern Europe: Production and Consumption of Primary Energy, 1974

German Democratic Republic
1. Schwedt
2. Rostock
3. Magdeburg
4. Greifswald
5. Rheinsberg

Poland
6. Upper Silesia

Czechoslovakia
7. Hodonin
8. Ostrava
9. Košice
10. Ostrava—Karvina Basin
11. Jaslovske Bohunice

Hungary
12. Budapest
13. Szeged
14. Mecsec Mountains

Romania
15. Ploeişti
16. Oltenia
17. Constanţa
18. Piteşti
19. Jiu Valley

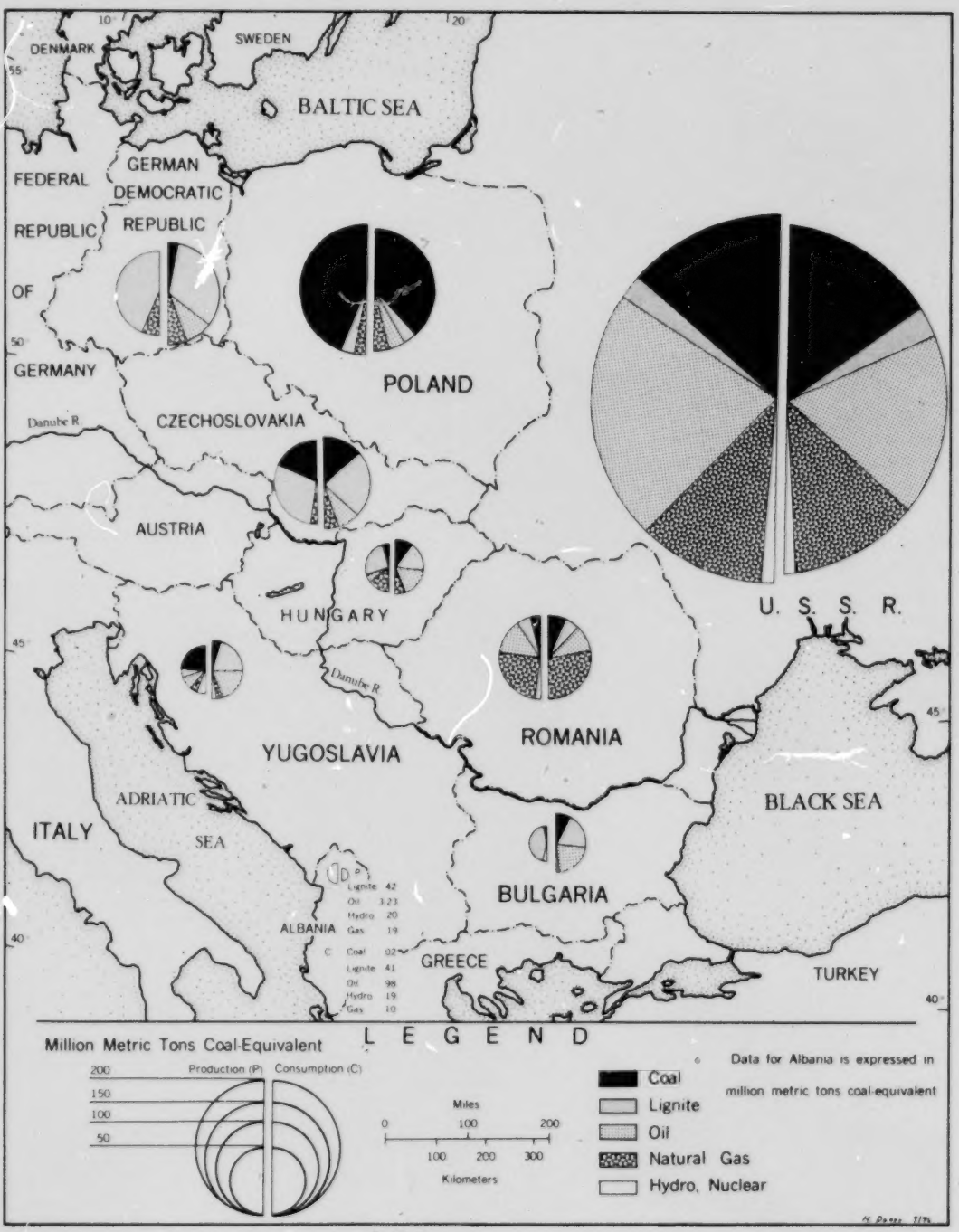
Yugoslavia
20. Banat
21. Krk
22. Sisak
23. Pančevo
24. Kosovo
25. Velenje
26. Kreka

Bulgaria
27. Pleven
28. Burgas
29. Vratsa
30. Kozlodi
31. Pernik

Albania
32. Qyteti Stalin
33. Vlorë

U.S.S.R.
34. Kiev
35. Tiraspol

FIGURE 2
Eastern Europe: Energy Resources and Pipelines



from Iraq and Libya. Chances for new oil strikes are small. Its supply will greatly benefit when the "Adria" pipelines have been completed. In 1974 Hungary met roughly 65 percent of its energy needs, though consumption is still on the rise. Other igneous fuels are coal, mostly lignite, and uranium, which are found in the Mecsek mountains located in the southwestern part of the country. Lignite is now largely used in the country's thermal power plants. The first nuclear power plant is to go into operation in the early 1980's.

Czechoslovakia's petroleum and natural gas requirements are almost wholly met by imports from the Soviet Union. Some oil is drilled in southern Moravia (Hodonin and Malacky) and natural gas near Ostrava and Kosice. Natural gas moves in a new pipeline from the Soviet Union to Italy, West and East Germany, which has a right-of-way through the country, enabling Czechoslovakia to both participate in its use and impose a small transit charge which is used in financing its needed imports.[17] In 1974 over 14.6 million tons of oil were imported (100 percent from the Soviet Union). Czechoslovakia's large reserves of bituminous coal and lignite are at the Ostrava-Karvina basin in Czech Silesia; and while bituminous production is slowly waning, that of lignite is ample. In 1974 nearly 28 million metric tons of bituminous coal were produced, the second largest production in Eastern Europe after Poland.

The country possesses considerable reserves of uranium with deposits located in the Jachymow district and the more recently developed Pribram and Dolni Rozince areas. New discoveries have been made in the North Bohemian area (Ceska Lipa and Liberec) and recently in the area stretching from the Czech-Moravian hills to the Sumava and Cesky Les Mountains.[18] The Soviet Union, since the end of World War II, has priority in exploiting these reserves. One large nuclear power plant has been completed and two are under construction.

East Germany until recently had only lignite as its indigenous fuel base. In 1974 production covered 72 percent of her domestic energy needs with most of her other energy requirements being imported. Imports of crude oil and natural gas are of particular importance for its expanding petro-chemical synthetic material industries. The rich deposits of lignite, worked by open-cast methods, are used as fuel for power stations as well as raw materials for the above cited petrochemical industries, which specialized already in the interwar period on such products as synthetic petrol, oils, and rubber, apart from chemicals. Crude oils are imported on the "Druzhba" (friendship) pipeline from the Soviet Union, terminating at the large refinery at Schwedt on the Oder. Pipelines from Schwedt and the new oil terminal at Rostock on the Baltic carry crude oil to all important industrial regions of the country. In 1973 Europe's deepest well, 23,295 feet, was drilled at Loissin near Greifswald in the Rostock area. A small but growing natural gas production is located 80 Km northwest of Magdeburg (Salzwedel/Pechensen). Soviet natural gas is brought to East Germany via the Transit pipelines running through Czechoslovakia. With recent new discoveries of natural gas, domestic output is growing rapidly. It is estimated that in 1975 it contributed roughly as much to the energy mix as oil. East Germany also has introduced a strict program of savings for oil and gas, but the problem is not an easy one. As Leslie Dienes pointed out, "six million tons of Soviet oil in the East German petrochemical and synthetic material industries is claimed to replace upward of 100 million tons of lignite, two-fifths of the current output from strip mines, where the ratio to overburden coal now exceeds 5 to 1."[19] While pollution problems certainly do not serve as constraints as in the Western countries, it is obvious that the replacement of oil by lignite, apart from an efficiency point of view, raises serious environmental problems. East Germany also has been constructing nuclear power plants. Two plants are operating, one at Greifswald and a smaller one at Rheinsberg.

Poland is the only net exporter of fuels in the region, due to its own sizeable coal deposits, located mainly in the Upper Silesian district. Coal accounts still for 80 percent of the country's total energy consumption. In addition to its large domestic consumption, Poland is able to export as much as 41 million tons (1975). In recent years natural gas production, largely from southeastern Poland, has been greatly accelerated, showing a twelvefold increase since the early 1960's. For its oil needs Poland is largely dependent on imports from the Soviet Union (1975 estimates speak of over 12 million tons of crude oil and products). Polish coal production increased by about 35 percent in the 1960's, and the temporary decline in the early 1970's has largely

TABLE 2
Oil Imports by the East European Countries, 1974

	Imports in 1,000 Metric Tons	Imports from the USSR in Percent	Oil Imports as Percent of Total Energy Consumption
Albania	0	0	0.0
Bulgaria	10,550	96.9	45.3
Czechoslovakia	14,660	100.0	17.0
German Democratic Republic (GDR)	16,430	86.1	17.0
Hungary	6,820	90.8	25.1
Poland	10,580	97.5	9.5
Romania	4,540	0	9.0*
Eastern Europe excl. Yugoslavia	63,580	87.3	17.7
Yugoslavia	7,420	28.3	27.4

*Romania exports refined petroleum products and imports crude oil.
Source: United Nations, *World Energy Supplies 1950–1974* (New York, 1976), pp. 235, 106–111.

been made up due to increased demands both from other CMEA countries and also Western exports earnings including the United States. About 10 percent of the country's total export was in bituminous coal. With such a large percentage of coal serving domestic needs, her overall dependence on imported energy is small, though her imports, mainly via the Friendship pipeline from the Volga-Ural fields, have increased. Reports about possible productive petroleum reserves in southeastern Poland have also been circulated. Some uranium is mined in Lower Silesia and the first nuclear power plant is due for operation by 1983.

The previous discussions have made it abundantly clear that solid fuels, and among them the low calorific lignites, still play a very decisive role in the energy mix of most of the East European countries. The changing emphasis during the last fifteen years from solid to liquid fuels has had important repercussions for nearly every one of the East European countries, but especially for those in which domestically mined coal thus far makes a major contribution to their energy mix, especially that of Czechoslovakia, East Germany, and Poland. Albania and Romania produce most energy for domestic production, mainly petroleum in the former and both petroleum and natural gas for the latter. Both countries export refined products, but Romania also imports crude oil. Romania, Bulgaria, and Yugoslavia have ample hydro reserves, while Bulgaria has given early emphasis to an accelerated nuclear program.

It is also clear from the foregoing discussions that, with the exception of Romania and Albania, all the East European countries are very deficient in hydrocarbon fuels. Their total energy dependency supplied by imported oil ranges from 9.5 percent for Poland to 45 percent for Bulgaria. A large percentage of these imports come from the Soviet Union (see Table 2). But in order to assure a dependable supply, especially in view of the Soviet Union's pressure to look for non-Soviet supplies due to its inability to increase at the present time its export commitments of oil and natural gas, the five most dependent East European CMEA members (Poland, East Germany, Czechoslovakia, Hungary, and Bulgaria) have made a series of agreements for supplies largely from the Middle East countries and Libya. As a result, some crude oil must be purchased on the world markets, thus far mainly by Bulgaria, East Germany, and Romania (though this is compensated for the latter by a substantial export of petroleum products). Shipments to Hungary, Poland, and Czechoslovakia, while hitherto relatively small, are expected to rise substantially in the years to come.[20] In 1974 net imports of crude oil from non-Soviet sources accounted for 12.7 percent,[21] or approximately 8 million tons of crude oil. An additional 6 million was imported by Yugoslavia. Soviet exports of crude and petroleum oil products to its East European allies for 1975 mention 72 million tons or 55 percent of the total exports of the Soviet Union (130 million tons). Estimates for import needs by 1980 differ widely and range between 75 and 130

million tons, with the Soviet Union supplying between 75 and 100 million tons.[21]

It is then clear that the Soviet Union is the obvious supplier of a substantial part of the needed fuel imports, but with supplies of petroleum and natural gas in its European part declining, the cost factor for supplies coming the long distance from Siberia plays an ever-increasing role. This was one reason the Soviet Union encouraged its East European CMEA partners to make their own import arrangements for hydrocarbon fuel needs with the countries from the Third World.

The constantly increasing requirements of oil and natural gas served as background for CMEA's decision to give increased attention to the utilization of cheaper indigenous thermal and hydroelectric power supplies and to adjust the prices of raw materials traded (including fuels) to bring those prices, as a recently published study by the Economic Commission of Europe emphasized, "closer to the level prevailing on world markets, and to revise the system by which these prices are to be determined in the future."[22] However, it should be pointed out that ultimately the Soviet Union could supply its East European CMEA allies with the needed petroleum and natural gas by pipelines from its territory. The first requirement is to make huge capital investments in the basic infra-structure in its far away, sparsely populated, and climatically inhospitable Asiatic regions where most of the future supplies are located before starting exploration, drilling, and transporting products located at considerable distances from its allies and even its own main markets.

Much has already been written and cited in the various references in this article about the future fuel supplies in Soviet Asia. Certainly the major changes in the regional production of Soviet oil in the last ten years have been the increasingly rapid build-up of reserves and supplies in spite of formidable economic and technical obstacles in West Siberia, Kazakhstan, and Mangyshlak. West Siberian production alone centered in Tyumen is expected to increase from 148 million tons in 1975[23] to 300 million tons by 1980 (planned target). One of the reasons for the sizeable price increases charged for Soviet raw materials, especially fuels, to its partners in early 1975 (an increase from 16 to 37 rubles retroactive to January 1, 1975) was to obtain needed investment funds for increased domestic production, though these prices are still below those on the world market which must be paid by the Western European countries. The nominal price for Soviet crude oil to its CMEA partners will further increase by about one-third in 1977 compared with an 8 percent increase in 1976. It is expected that by 1978 the "price differences between world and intra-CMEA prices for oil should be largely wiped out."[24] These price increases, together with a policy of no substantial increases of oil and natural gas supplies from the Soviet Union during the next few years, will force the East European importers of Soviet supplies to make major adjustments in every aspect of their economic planning and may very well hamper projected growth and more serious, much needed modernization in industrial production and the standard of living of its people.

Resource Politics and Resource Dependency

It is obvious from this brief analysis that most of the countries of Eastern Europe rely heavily on oil and natural gas available in the Soviet Union and, as far as oil is concerned, increasingly on some Arab countries. Recent research in the power relationship between the East European countries and the Soviet Union has increasingly come to the conclusion that it is Eastern Europe—with the exception of Yugoslavia and perhaps Romania and obviously Albania—that is dependent upon Soviet assistance in terms of resource supplies,[25] while trading with the East European CMEA countries "actually results in a loss for the Soviet Union."[26] That these countries must pay a price for this dependence in terms of Soviet demands is only too obvious. Inasmuch as much of the payment for Soviet oil and natural gas deliveries is in non-convertible currency and often poor quality but rather high-priced manufactured items, the question could be raised whether an expanded trade with the Soviet Union to buy high technological know-how and obtain capital intensive investments may not be of greater use to Eastern Europe than the current policy which is a form of barter between raw material supplies from the Soviet Union and manufactured products.

Recent discussions in East European literature have raised a very important question about the Soviet Union's interest in continuing the export of raw materials, including oil and natural gas, to other CMEA countries, since their recent emphasis on developing industries for export purposes is becoming less and less ad-

vantageous for the Soviet Union.[27] Also, as a result of such shipments of oil and to a lesser extent natural gas to its allies, net Soviet exports to Western countries were sharply reduced until 1974. Taking advantage of the increased world prices for petroleum, "the flow of crude oil to the West went up (1974 to 1975) forty percent to 480,000 barrels a day, while exports to Communist nations rose eight percent to 1.6 million barrels daily."[28]

It is clear that the establishment of gigantic economic enterprises in the East European countries resulted in "economic progress for more than two decades and this was accompanied by large increases in the need for raw materials and fuels . . . since raw materials are unevenly distributed among the member countries, from the beginning the international division of labor played an important role. . ." These discussions also stress that, despite the building of oil and gas pipeline connections and the United Electric Power Grid System (MIR) between the Soviet Union and the East European countries (only Albania is not included) and to some extent even with the Western countries, the raw material supply problem of these countries has become even more serious in view of the increased prices. A recent article in the Hungarian paper *Nepezabadsag* summarized the supply problem:[29]

(1) The shifting raw material exploitation, especially energy resources, to the areas beyond the Urals raises a series of important economic and technological problems. The European CMEA countries until now have received most of their oil from European Russia (Volga-Ural region, the Ukraine), and with a changing location in the resource base, necessitated by the growing shortages in European Russia, major cost factors cited earlier will play a very important role.

(2) The shifting exploitation of oil reserves to western Siberia and their shipment to far away East European countries demands huge capital outlays and requires much manpower working in a hostile climate.

(3) It is generally agreed that the Soviet Union's exploitation and export of raw materials and fuels to the East European countries is more costly in terms of equipment (3 to 3.5 times) than would be required by manufacturing the machines the Soviet Union receives in exchange; "the value of the raw materials and fuels exported by the Soviet Union to the member countries is three times greater than what it imports from them."

(4) Finally, the Soviet Union by exporting oil and natural gas to the Western industrialized countries, can in return obtain the latest technical know-how which in turn contributes to a more rapid development of its own industrial production and technological level.

The moral of this is clear. East European countries are forewarned that major changes and sacrifices, in terms of closer integration in planning, will be expected in return for additional economic aid, i.e., raw material, especially oil and natural gas shipments. Specifically, the East European CMEA countries will have to make considerable investments in the development of Soviet natural resources, including providing manpower for their development, in changes in the production structure, i.e., by savings on energy and material-saving technologies, and often changes in the East European import policies, to obtain needed resources from the Soviet Union. The concern by the Soviet Union was already clearly expressed in the 1971 CMEA Comprehensive Program which gave special attention to resolving the raw material problems by closer integration and cooperation among its members, but also by improving the quality of East Europe's exports to the Soviet Union. Special attention was also directed to the production structure in the CMEA countries which generally use much more raw material and fuel than the Western industrialized countries. (Estimates here go as high as 70 to 80 percent more energy-producing materials to produce the same unit of GNP). In brief, the East European countries must ease the investment burden of the Soviet resource shipments, but hopefully, the Soviet Union may also find Western investors, including the United States and Japan, who will assist in opening up their enormous reserve located in the far away Asiatic region.

The East European countries have no other way to go, and in spite of the recent price increases for fuels and other raw materials, the prices paid are still well below world market prices paid by the Western industrialized countries. Western Europe must import its fuels and metals from the Third World countries, and East European countries shopping in the Third World, in spite of their much closer relations, would have to compete on the world markets. In addition, they must make their payments in hard currencies.

It is clear that for all East European countries, savings in their use of oil and natural gas and key ferrous

and non-ferrous metals must have high priority. To counter the impact of the raw material price increases, according to a recent report by the Economic Commission of Europe, United Nations,[30] all the CMEA countries have embarked on a program of reducing the use of energy by eliminating waste and increasing the recycling of products; increased use of material-saving technologies, including the replacement and modernization of inefficient energy-using equipment; raising the efficiency of electric power transmission; a greater emphasis on coal as an emergency source; and the building of nuclear and, whenever feasible, hydro power plants. Certain savings on raw materials such as paper, glass, and rubber as well as some basic chemicals will obviously have an indirect effect on energy savings. In addition to direct raw material and especially energy savings, greater international cooperation, i.e., between the individual European CMEA members and the Soviet Union, are envisioned.

The earlier mentioned national electric grid system (MIR-Peace), integrating the power supplies of all the socialist countries (including Yugoslavia, but excluding Albania) with that of the Soviet Union and further integration of oil and gas supplies by the expansion of the existing pipeline network of the Friendship and Bratstvo (brotherhood), will further contribute to CMEA's energy economy. In view of the more expensive transportation of gas by pipeline than of petroleum, the diameter of the newly constructed gas pipeline, and the joint development of the 2,750 km Orenburg-Uzhgorod gas line with investments and/or workers by all the East European CMEA members, are already underway. (The East European CMEA countries are providing close to $1.5 billion toward the construction at an interest rate of 2.0 to 2.5 percent, but nearly 20,000 workers help build the pipeline). The recently signed agreement with Kuwait and Libya and the World Bank to start construction of the long contemplated "Adria" pipeline will give Yugoslavia, Hungary, and Czechoslovakia, and possibly Poland greater leeway in their fuel requirements by importing directly from Third World countries. Accelerated drilling with the help of experts from non-CMEA countries and foreign oil companies is also underway and should ultimately increase the ability of East European countries to earn foreign currencies. The recently established CMEA *Interatomenergo* agency for the purpose of joint nuclear research will greatly facilitate this search for reducing East Europe's dependence on Soviet supplies. The earlier mentioned cooperation within the national grid system of the European CMEA members and Yugoslavia is also expanded by cooperation with non-CMEA members, especially Austria, whose grid system in turn is tied to the major European system.[31] All these linkages extend to the West European countries, bringing much needed fuel to the industrialized countries. The supply of natural gas to Austria, Italy, France, West Germany, and other West European countries is only one example. The increase of the capacity of the Czechoslovakian transit line by 1979 which takes Soviet natural gas supplies not only to Czechoslovakia, but also to East Germany, Austria, Italy, and West Germany is another example (the present through-flow of 12.6 billion m^3 is ultimately to reach 37 billion m^3 per year). With increased cooperation between East and West and especially investment by the industrialized countries, including the United States, in some of the East European countries such as Romania, Poland, and the older established links with Yugoslavia, more open trade will be possible and some of the dependence of the East European countries on any one individual country can perhaps be lessened. But in reality it is clear that the Soviet Union can never be replaced as a major and often decisive source of raw materials.

The top priority of the future will be the opening of Siberia with its abundant fuel and metal reserves.[32] This is of importance to the countries of Eastern Europe, the Soviet Union's domestic needs, as well as to the rest of the world. With nearly 50 to 60 percent of the Soviet energy potential alone located in its Asiatic region (counting only proven and recoverable indicated reserves) and considering the high cost producing factor, including the distance between the location of the resources and the markets, it is obvious that considerable capital investment, equipment, and manpower are essential to make these resources available. For the moment, though, it is clear that continuing large deliveries of petroleum and natural gas can only be expected from the Soviet Union if its Asiatic region is opened and if investments—East European and/or industrialized nation financed—can be found.[33] In the meantime, and with a few exceptions, the percent of crude oil deliveries from the Soviet Union can only be

expanded with some difficulty (they rose by an unexpected 8 percent in 1975), and thus the needs of the East European CMEA countries must be supplemented with purchases on the world market and by savings and greater utilization of the available fuels. These purchases, according to a recent compilation assuming imports of 12 million tons of crude oil from the Third World in 1973–4 "represent roughly 8 percent of their entire 1973 imports from the non-communist world."[34]

Considering the present economic and political power relations between the East European CMEA countries and the Soviet Union, it is essential to realize the comparative advantage of Soviet raw materials and especially fuels to the economies of these countries. From a Soviet point of view, to the question "Has Eastern Europe become an economic liability to the Soviet Union, and will the Soviet Union try to reduce or even abandon this liability?" the answer is a clear "yes" to the first part of the question,[35] but an emphatic "no" to the second part. Soviet-CMEA relations, both costs and benefits, must be weighed in terms of economic and political costs, including their strategic aspects within a world-wide geopolitical framework. Therefore, Soviet economic assistance to its Eastern European allies must continue and in the years to come may very well substantially increase. On the other hand, Soviet pressure for accelerated economic and political integration of the East European economies with their own needs will be on the increase both in the short and long run.

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An expanded version of this paper entitled "Eastern Europe: Resource Politics. Economic Development and Resource Dependence," by George W. Hoffman will appear in *A Geography of Europe, including the Soviet Union: Problems and Prospects*, edited by George W. Hoffman, 4th edition, (New York: The Ronald Press Company, to be published in 1977), chapter 10.

Most statistical data used in the following pages are from the various publications of the United Nations and from preliminary trade figures published in Soviet journals. UN publications give crude oil production in million tons a year/with 1 million tons roughly 20,000 barrels a day, or 1 ton a year equal to 7.3 bbl. One ton of standard (or conventional fuel)=7 million kilocalories; 1 ton of crude oil=10 million kcal (1.43 for standard fuel); natural gas=8.8 million kcal (1.25 for standard fuel).

1. For the purpose of these discussions the following countries are included: the German Democratic Republic (East Germany), Poland, Czechoslovakia, Hungary, Romania, Bulgaria, Yugoslavia, and Albania. These countries excluding Yugoslavia and Albania are also referred to as the European members of CMEA, the Council of Mutual Economic Assistance, though the U.S.S.R., Mongolia, and Cuba are also members of CMEA (the name COMECON is often used in the Western countries).

2. J. Richard Lee, "Petroleum Supply Problems in Eastern Europe," in U.S. Congress Joint Economic Committee, *Reorientation and Commercial Relations of the Economies of Eastern Europe* (U.S. Government Printing Office, Washington D.C., 1974), pp. 418–419 for 1960–1973; *Petroleum Economist*, August 15, 1975, p. 302. The author's figures are estimated on production plus net trade of crude oil and petroleum products.

3. Robert W. Campbell, "Siberian Energy Resources and the World Energy Market," in *Exploitation of Siberia's Natural Resources*, ed. M. Yves Laulan (NATO, Directorate of Economic Affairs, Brussels, 1974), p. 79. Professor Campbell commented that "actually the U.S.S.R. provides more than their total deficit, so that they are able to achieve a small net export of petroleum products to countries outside the group, and Poland has significant exports of coal to non-socialist countries." See also the valuable study by Arthur W. Wright, "Soviet Energy Decisions, World Markets, and Options for Western Energy Policy," in the above quoted study, pp. 133-138. Also Alan B. Smith, "Soviet Dependence on Siberian Resource Development," (preliminary paper presented at annual meeting of AAASS, Atlanta, Ga., October, 1975), Table 5, p. 36. The estimated figure of 59 million tons in 1974 is generally thought to be too low, and a figure of 65 million tons for 1974 is closer to actual Soviet exports. The figure of 72 million tons is taken from *Ekonomischeskaia gazeta* No. 19 (May, 1976), p. 21.

4. Campbell, Siberian Energy Resources . . , *op. cit.* (see footnote 3 above), p. 79.

5. Leslie Dienes, "Energy Self-Sufficiency in the Soviet Union," *Current History*, Vol. 69, August, 1975, p. 50; United Nations, Economic Commission for Europe, *Economic Survey of Europe in 1971*. Part I: *The European Economy from the 1950s to the 1970s* (New York, 1972), p. 87.

6. United Nations, *World Energy Supplies 1950–1974*, (New York, 1976), pp. 106–111, 95.

7. It is estimated that the Soviet Union is self-sufficient in 26 of the 36 minerals generally considered as essential to modern industrial processes as against the United States' seven. For details see Central Intelligence Agency, *Soviet Long-Range Energy Forecasts* (ACSR) 75-71, September 1975).

8. Paul Marer, "Has Eastern Europe Become a Liability to the Soviet Union—The Economic Aspects," in *The International Politics of Eastern Europe* (edited by Charles Gati; to be published by Praeger Publishers in late 1976). Robert W. Campbell, "Some Issues in Soviet Energy Policy for the Seventies," in U.S. Congress, Joint

Economic Committee, *Soviet Economic Prospects for the Seventies* (U.S. Government Printing Office, Washington D.C., 1973), pp. 45–55.

9. Lee, *op. cit.* (see footnote 2 above), pp. 418–419.

10. The following is only a selected list of the more recent literature which I found of special value: Violet Connolly, *Siberia Today and Tomorrow. A Study of Economic Resources. Problems and Achievements* (Collins, London, and Glasgow, 1975); Ian F. Elliot, *The Soviet Energy Balance: Natural Gas, Other Fossil Fuels, and Alternative Power Sources* (Praeger Publisher, New York, 1974); Robert W. Campbell, *The Economics of Soviet Oil and Gas* (The Johns Hopkins Press, Baltimore, 1968); Arthur W. Wright, The Soviet Union in World Energy Markets, in *The Energy Question—An International Failure of Policy*, edited by Edward W. Erickson and Leonard Waverman, (University of Toronto Press, Toronto, Canada, 1974); Walter Gumpel, "The Energy Policy of the Soviet Union," in *The Western World and Energy* (edited by C. Gasteyger, *Atlantic Papers*, January, 1974), pp. 37–51; Marshall I. Goldman, "The Soviet Union," in *Daedalus* (The Oil Crisis in Perspective), Vol. 104, fall, 1975, pp. 129–144; Leslie Dienes, "Geographical Problems of Allocation in the Soviet Fuel Supply," *Energy Policy*, Vol. 1, July, 1973, pp. 3–20; his earlier cited study "Energy Self-Sufficiency . . ." *op. cit.* (see footnote 5 above), as well as a yet unpublished study "Energy Policy Changes and Prospects in East Central Europe," of March, 1976, and a recently completed study to be published in the September 1976 issue of *Current History*, "Soviet Energy Resources and Prospects;" Lee, *op. cit.* (see footnote 2); Jozef Wilczynski, "Atomic Energy for Peaceful Purposes in the Warsaw Pact Countries," *Soviet Studies*, Vol. XXVI, October, 1974, pp. 568–590.

11. The references cited in footnote 10 together with the information published in the sources listed below on raw materials, production plans, and policies in individual East European countries, served as an important source of information in the discussions on individual countries: *Soviet Analyst, Petroleum Economist, the Economist, Soviet Geography, Soviet News, World Oil, the Economic Bulletin of Europe,* and *the Economic Surveys of Europe* (United Nations, Economic Commission for Europe), *Petroleum Press Service, Radio Free Europe Research, Background Reports,* etc. In addition to these sources, publications from individual countries, including statistical yearbooks and other summaries have served as background material.

12. Romania's deepest well is located at Liliesti (Prahova area) at 20,506 feet and produces about one-third of the country's oil. Danilo A. Rigassi, "USSR Becomes the World's Leading Oil Producer," *World Oil*, Vol. 181, August 15, 1975, p. 134.

13. J. H. Chesshire and Miss C. Huggett, "Primary Energy Production in the Soviet Union," *Energy Policy*, Vol. 3, September, 1975, p. 236.

14. Harry Trend, *The Orenburg Gas Project.* Radio Free Europe Research RAD Background Report/165 (Eastern Europe), December 2, 1975. Also *Ekonomischeskaia gazeta*, No. 14 (April, 1976), p. 1 and Moscow Narodny Banka, *Press Bulletin*, April 14, 1976, p. 8; April 28, 1976, p. 6 and June 2, 1976, pp. 4, 10–11.

15. Data of imports into the various East European countries vary greatly with different sources. This figure was taken from United Nations, *World Energy Supplies, 1950–1974* (New York, 1976) pp. 234–235. J. L. Kerr, *East European Imports of Crude Oil.* Radio Free Europe Research. RAD Background Report/12 (Eastern Europe), January 31, 1975, reports in the Annex 1972 crude oil imports only of 6.37 million tons from the Soviet Union and 1.91 million from other countries. Robert W. Campbell in an unpublished paper of June, 1975, "Eastern Europe Trade in Crude Oil and Petroleum Products, 1965–1974," summarizes the main features of the trade in crude oil and petroleum products and is especially concerned with the question if perhaps "there was any possibility that some Middle Eastern oil shown in the Soviet statistics as Soviet exports to some Eastern European country might not be shown in the East European statistics as an import from the Middle East rather than from the USSR." But, as he emphasized "I find no support for that hypothesis."

16. Wilczynski, *op. cit.* (see footnote 10 above) and United Nations, Economic Commission for Europe, *The Economic Survey of Europe in 1975* (mimeographed copy, Part I. Chapter 2, GE. 76-43037).

17. Radio Free Europe Research, *Third Branch of the Transit Pipeline under Construction.* Czechoslovak Situation Report/32, August 13, 1975, pp. 8–11.

18. "Uranium Yesterday, Today and Tomorrow," from *Hornik A Energetik*, No. 47, November 20, 1975 as translated in Radio Free Europe Research, Czechoslovak Press Survey, No. 2556, December 29, 1975, pp. 1–5.

19. Dienes, Energy Self-Sufficiency . . . *op. cit.*, (see footnote 5 above), p. 49.

20. "East Europe's Fading Surplus," *The Petroleum Economist*, June, 1974, pp. 204–205.

21. Dienes, Energy Policy Changes and Prospects . . . *op. cit.* (see footnote 10 above), pp. 24–25 and Soviet Energy Resources and Prospects, *op. cit.* (see footnote 10); Chesshire and Huggett, *op. cit.* (see footnote 13 above), pp. 235–7, including Tables 9 and 10.

22. The Economic Survey of Europe in 1975, *op. cit.* (see footnote 16 above), p. 43.

23. *Soviet News*, No. 5777, March 11, 1975, also Chesshire and Huggett, *op. cit.* (see footnote 13 above), Table 1, p. 223; *Soviet Geography*, Vol. XVII (May 1976), p. 349.

24. Harry Trend, *Soviet Crude Oil Price to COMECON May Be a Third Higher In 1977.* Radio Free Europe Research. RAD Background Report/18 (Eastern Europe), January 20, 1976; also *Some Effects of COMECON's Revised Price System.* Radio Free Europe Research. RAD Background Report/27 (Eastern Europe), February 20, 1975. Trend comes to the tentative conclusion that Soviet deliveries of crude oil and petroleum products to the six East European CMEA countries will triple their payments between 1973 and 1975 (883 million rubles to 2,470) with Czechoslovakia and Hungary being affected most, and Romania, which buys no oil from the U.S.S.R., least. Marer, *op. cit.* (see footnote 8 above), pp. 19–20 in using these compilations as a basis, estimates a one-third increase between 1973 and 1975 if applied to all exports of energy, raw materials, and semi-finished goods.

25. Thad P. Alton, "Economic Growth and Resource Allocation in Eastern Europe," in *Reorientation and Commercial Relations of the Economies of Eastern Europe* (U.S. Government Printing Office, Washington D.C., 1974), pp. 251–268; Marer, Has Eastern Europe Become a Liability . . . *op. cit.* (see footnote 8 above) and "Economics and Integration in Eastern Europe," (paper presented at conference on "Eastern Europe: Stability or Recurrent Crises?" Arlie House, Warrenton, Va. November, 1975).

26. Marer, Has Eastern Europe Become a Liability . . . *op. cit.* (see footnote 8 above) quoting from a paper by Edward A. Hewett, "Prices and Resource Allocation in Intra-CMEA Trade," (paper presented at a conference on "The Consistency and Efficiency of the Socialist Price System," University of Toronto, March, 1974).

27. "Comecon Supplies of Raw Materials," *East-West*. vol. 5, No. 104 (March 29, 1974), pp. 1–2; also *East-West*, No. 82, p. 9.

28. Theodore Shabad, "Russians Step Up Oil Exports to West," *The New York Times*, May 24, 1976, p. 46.

29. "Comecon Supplies . . . *op. cit.* (see footnote 27).

30. The Economic Survey of Europe in 1975, *op. cit.* (see footnote 16 above), pp. 43–48. As an example of this trend, the report points out that due to the recent emphasis on coal production, the annual growth rate of coal output which had fallen as low as 1.6 percent in the years 1966–71, was reversed in the years 1971–75 and showed an average growth rate of 2.1 percent (p. 46).

31. The three major European grid systems now in existence have started to cooperate in the exchange of power. They are (1) UCPTE (Union for the coordination of production and transport of electric energy) with membership mostly among West European countries including Austria, and working closely with SUDEL (Greece, Italy, Yugoslavia, and Austria), and the UFIPTE (France, Portugal, and Spain) system; (2) the MIR (COMECON) system; and (3) NORDEL (Norway, Denmark, Sweden, Iceland, and Finland). Austria serves as the link cooperating with Yugoslavia, Hungary, and Czechoslovakia, and a possible cooperation with Poland is now under discussion. For details see Leopold Bauer, "Elektrischer Verbundbetrieb in Ost und West," *Osterreichische Osthefte*, Vol. 16, 1974, pp. 59–73. The papers presented by representatives from the different systems were given at the symposium of the Sudost Europa Gesellschaft (Munich), September, 1973.

32. When speaking of future Siberian developments, one should make a distinction between its western, central, and eastern parts, with western Siberia already in the initial stages of development. See also the discussions by the late A. A. Mints, "A Predictive Hypothesis of Economic Development in the European Part of the USSR," translated from Russian by Theodore Shabad in *Soviet Geography*, vol. XVII, No. 1 (January, 1976), pp. 1–28 and especially the section entitled "Evaluation of the Energy Position of the European Part of the USSR," pp. 11–14. See also the discussions by Theodore Shabad, "News Notes," *Soviet Geography: Review and Translations* (May, 1975), p. 334 and *Neftianiki*, No. 6, (1975), p. 7 and Dienes, Soviet Energy Resources and Prospects, *op. cit.* (see footnote 10).

33. "Russia Faces Tightening Crude Oil Supply Situation" *The Oil and Gas Journal*, vol. 75, No. 15 (April 12, 1976), pp. 27–29.

34. Dienes, Energy Policy Changes and Prospects, *op. cit.* (see footnote 13 above), p. 13 and Central Intelligence Agency, *Handbook of Economic Statistics, 1975* (Office of Economic Research, Washington, D.C., August, 1975), p. 59.

35. See Marer's two studies, *op. cit.* (see footnote 8 and 26 above) and especially his conclusion in *op. cit.* (see footnote 8 above) pp. 19–21; also Dienes, Energy Self-Sufficiency . . . *op. cit.* (see footnote 5 above), pp. 49–51. My conclusions are in full agreement with those expressed in the detailed analysis by Marer and other American scholars who have analyzed this problem in depth.

Discussion

Question: We speak of the Communist countries these days as the Socialist countries, I wonder why? Either the Socialists are Communists and then we called them Communist or they're not, although I don't believe in being a little bit pregnant, either you are or you're not. So I think if they are Communist then let's call them Communist. It's silly to come around and call them Socialist when there are some people who are Socialist and do not identify with the Communists. Isn't that right? So I don't know that we are paying a little bit of lip service to the Communists by calling them Socialist. Another question: What is your impression of the standard of living in the Eastern European countries, and by that, I not only mean the material standard of living but the so-called spiritual standard of living, the liberties, and the right to think without restrictions? Question 3: What is the present elasticity coefficient regarding the energy area? Question 4: What is the level of trade between Albania, Romania, and Yugoslavia with Russia since they are the heretics? Question 5 deals with the energy supply for the European members of CMEA. Is it tight and trouble-free? Really what has been the impact of the energy crisis on these countries? I believe the conclusion is that it is not trouble-free, but I want you to answer this. And finally, I would like to raise the question as to whether Russia really is unable to supply its allies with energy or is it a political move to keep them from growing too big?

Hoffman: You have a whole list of questions. I really could give you another lecture or even more than one. But let me answer your questions briefly, as best as I can. You are certainly correct, it is a well-established fact that all the CMEA countries have Communist governments. Most of them call themselves officially either "People's Republic" or "Socialist Republic." Not a single one uses the name "Communist Republic." I have followed the official terminology here. But obviously there are basic differences among the countries with Socialist governments, e.g., Sweden, the Federal Republic of Germany, the United Kingdom, to mention only a few, and those with communist dictatorships calling themselves "Socialist" or "People's Republic." (2) You raised the question about the standard of living in the East European countries . . . I have traveled in all the East European countries numerous times since the war, and I would say that there is no question that the standard of living has greatly increased in all countries, especially when compared with the prewar period, but also between the 1960's and the present time. But such a comparison should be considered relatively. Friends of mine say that when you go from Russia to Yugoslavia, it is a different world. I find the same between Yugoslavia and Bulgaria. Therefore, in answer to your question I would say yes, it has increased. There are many goods which the people have today which they could not afford a few years ago. But some food items are still in short supply or at times unavailable, and most luxury items are unavailable or so expensive that the average citizen simply can't afford them. (3) You raised the question about the present elasticity coefficient regarding energy. Briefly, one can say that most East European countries have greatly improved the efficiency of energy utilization, in part due to the gradual conversion to hydrocarbon fuels which contributed to a lower than unitary energy-GNP elasticity coefficient. As Professor Leslie Dienes in a recent study commented, "the precise weight of this influence, however, is impossible to unscramble." It also should be pointed out that East Germany, Poland, and Czechoslovakia, the more advanced East European countries whose economies have reached a higher level of energy intensity, showed below unity elasticity coefficients, while less developed East European countries such as Romania and Bulgaria showed above unity figures. This is related to the fact that these countries are still engaged in building heavy metallurgical and chemical industries. But basically it is a fact that there continues a big difference between the West and the East European countries between their gross and net energy demands. (4) In answer to your question concerning the level of trade between Albania, Yugoslavia, Romania, and the Soviet Union, let me say that Albania's trade with the Soviet Union is minimal. Yugoslavia's trade with the Soviet Union in 1973 amounted to 11 percent of its total trade turnover, 16 percent with the other European

CMEA countries, but 51 percent with Western Europe, and 22 percent the rest of the world. Romania's trade with the Soviet Union amounted to 21 percent of its total trade, 22 percent with European CMEA countries, 36 percent with Western Europe, and 21 percent with the rest of the world. It is interesting to note the change in Romania's trade between 1965 and 1973. In 1965 for example its trade with the Soviet Union amounted to 30 percent, with the East European CMEA countries 21 percent, with Western Europe 28 percent, and with the rest of the world 12 percent. Looking at all the East European CMEA countries, one can generally see the same trend, with the exception of Bulgaria where trade with the Soviet Union has increased to more than one half of her total trade. Your fifth question dealt with the impact of the energy crisis on the East European economies. The impact together with the West European inflation has left its mark in every one of the East European countries. The energy crisis has meant greater dependence on Soviet supplies, in spite of price increases (still somewhat below world market prices), and together with inflation the meager foreign currency reserves which used to buy Western technology and some luxury items now must be used for oil in the Third World countries and for investments to be made in the Soviet Union (pipelines). Inflation has meant that much needed Western goods have greatly increased in price and again take more of their foreign currencies.

Your final question is closely related to one I just briefly answered. But let me expand on it. Crude oil supplies in the European part of the Soviet Union have definitely been declining; those at Baku are literally gone, and even those in the so-called "second Baku," in the western Urals, are declining. The oil fields which have greatest potential are those in Siberia, particularly western Siberia, the Tyumen fields. But their distances to the markets are considerable, and as I pointed out earlier in my paper, drilling is in a most inhospitable climate and in areas with poor or no infra-structure. Therefore it is not a question of whether the Soviet Union will be able to supply its European allies. It is a question if it can meet all of its allies' needs. It is clear that in the next few years Soviet petroleum output is going to be tight, and that until additional supplies are available from Siberia, the East European CMEA countries will have to reduce their needs and, in addition, buy more supplies from the countries of the Third World, mostly the Arab countries. The Soviet Union has made commitments to some Western European countries for the delivery of crude oil and natural gas, e.g., West Germany, Italy, Austria, and these shipments are of importance to the Soviet Union. This is one way for the Soviet Union to obtain much needed advanced technology in return for oil and gas shipments. This is not a question of the Soviet Union simply curtailing or stopping oil and gas supplies to the West and increasing those to Eastern Europe. Therefore, considering the Soviet Union's commitments to the West and the East and its own supply and demand situation for the next few years, it is clear that the European CMEA countries are in a rather difficult situation. As you are aware, the Soviet Union has hoped to entice the United States and Japan to invest in their oil explorations in Siberia. When some of our oil people went to Siberia to see for themselves future possibilities, they really did not see much. In any case, for a variety of reasons nothing as yet has come about concerning such possibilities, and the chances are slim that U.S. and even Japanese money will go into Siberian exploration. In conclusion, my answer to your question is clear. There is no question in my mind that the Soviet Union has supply problems if they keep up with their other commitments. One way to ease the supply problem is greater emphasis on the use of coal and especially lignite which is in ample supply. If one looks at the individual country statistics in Eastern Europe, one can see that lignite production has increased considerably. Americans may be concerned about the increased pollution such a shift produces, but Americans can't think in American terms when talking about East European developments. The question of pollution in the East European countries simply does not play the role it plays in the advanced industrialized countries. In a Socialist society priorities are different, and in the East European countries saving of oil and gas is more important than giving attention to pollution. If pollution con-

trols can be introduced with no extra costs or only with minor additional costs, that's fine. It is for this reason that they told their East European allies to look for non-Soviet supplies for increasing needs. There is only one exception among its European allies. You may remember that I pointed out that Romania is the least dependent on Soviet supplies, and I mean here fuels and minerals, but Romania is also precisely the most independent of its CMEA allies. Yugoslavia, naturally, has not been part of the Soviet system of alliances since the late 1940's. Its needed supplies come largely from the Arab countries.

Kozmetsky: What about Soviet crude oil prices?

Hoffman: According to a recent research report in Radio Free Europe the nominal price for Soviet crude oil shipments to its European allies rose by 8 percent in 1976 and may rise by another one-third in 1977 when price differences between intra-CMEA prices for oil should come close to world prices. A new price formula with greater price flexibility on an annual basis was adopted in January 1975 by the CMEA Executive Committee which called for higher prices in two phases. The whole pricing formula is a very complicated one and also depends on counter-deliveries made as payment for Soviet oil and their prices. The 1975 crude oil prices were set at a level about 130 percent above the 1971–74 prices.

Question: I have this question. What is your impression about the possibility of Eastern Europe becoming completely dependent on Arab oil, since they are already moving in that direction? And how about Sheikh Tariki's comments and friendly attitude about cooperation between the Arab producing countries and Western and Eastern Europe to produce another source of energy?

Hoffman: Well, I certainly can't speak for Sheikh Tariki, but the fact is that at this stage of development the Soviet Union has encouraged the East European countries to buy oil from the Third World countries, but the problem of financing these purchases is a serious one. They just don't have the foreign currency. Much of the trade is therefore by barter agreements. It also must be said that the East European countries today make much more efforts in conservation, including a shift from oil and gas for extra costs. Pollution must be taken as part of a modernization process and savings to the whole economy. All in all, the East European countries try to conserve on oil and gas and a recent UN report spoke of a major effort along those lines. Now, I realize that your major point dealt with a possible dependency on the Arab countries by the East European members of CMEA—could they exchange Soviet dependency with Arab dependency? I really think this is impossible. The Soviet Union would certainly see to it that this does not happen economically and politically. A small supply of Third World and/or Arab oil together with rigid conservation measures and a rapid increase in their nuclear capabilities are the basic policies pursued by the East European countries. Too great a dependency on Arab oil is not possible for another reason. In spite of their generally excellent relations with the Arab countries, payments for oil would have to be made in hard currencies—business is business—and hard currency is in extremely short supply in all East European countries and has for some time been earmarked for advanced technologies.

Question: I would like to ask you the price and the cost of producing electricity; is oil or nuclear energy cheaper and which one is more effective?

Hoffman: I am not the specialist in that and simply can't answer this question in any detail. But please remember, that the price of oil depends on many factors. Also, in one country it may be one way and in another country another way. Politics always plays an important role. But it certainly is clear that producing a kwh of energy from oil is more expensive when compared with coal and a nuclear source.

Woodson: Of course, it does depend very strongly on the price of oil, but at the current world price of oil in the free world, for example, you produce energy from a nuclear source at about half the cost of producing it with oil. The oil-produced kilowatt hour costs about twice as much as the nuclear-produced kilowatt hour. And that's a matter of fact in this country, as a matter of practice, good experience.

Kozmetsky: What about coal, Herb?

Woodson: Coal is about half way in between. Coal is less expensive than oil but more expensive than nuclear.

Session III — Energy Impact on Societal Factors

Energy and the Quality of Life

Professor Elspeth Rostow
Dean of General and Comparative Studies at The University of Texas at Austin

Discussion

Energy and Food Production

Mr. C. W. (Tex) Cook
Former Chairman of the Board of General Foods Corporation

Discussion

Energy and International Finance

The Honorable Peter G. Peterson
Former Secretary of Commerce of the United States

Discussion

Energy and Economic Growth

Dr. James W. McKie
Dean of the College of Social and Behavioral Sciences at The University of Texas at Austin

Discussion

Energy and the Quality of Life

Professor Elspeth Rostow
Dean of General and Comparative Studies
The University of Texas at Austin

This session of the conference will explore the impact of energy on various aspects of social and economic behavior. It is my task to discuss the realtionship between energy and the quality of life. Before anyone addresses such a large subject, he or she should indicate what competence, if any, he possesses. You will hear me speak as someone concerned with the quality of life because of my interest in history and politics; you will not hear me speak as an expert on energy. First of all, I should like to explain what I mean by the concept of "the quality of life." It is not a phrase on which there is universal agreement. This is inevitable because the definition of "quality of life" must be an individual perception, as well as a social conclusion. I shall begin by mentioning two elements within the quality of life, the first temporal, the second comparative. On the first point, I believe that the individual perceives the quality of his life in terms of where he was at an earlier period (say a decade ago) in contrast to where he is now, all of this cast against his expectation as to where he may be ten years hence. The temporal definition of quality of life is thus usually a curve; if the individual feels his curve is going upward, on the whole he tends to assume that the quality of his life is improving. If, however, the assumption is that ten years earlier the quality of his life was measurably better and that ten years hence it will be worse than at present, the evaluation of the quality of life is negative.

A second element in the definition focuses on the difference between societies as perceived by their citizens. Here communications play an important role. If communications are such as to give the individual some sense of how life is ordered elsewhere and if he feels that he is relatively underprivileged, even though

his curve of individual perception may be moving upward, his sense of individual well-being and personal opportunity will seem low. For example, in developing areas since World War II where individuals either through the transistor radio or later through television have gained some sense that there is wider opportunity elsewhere (perhaps in cities within the country or perhaps in other more advanced societies), then the individual may be keenly aware of the gap between the quality of *his* life and that of others. It is often a painful gap. To be sure, if television and radio bring in violence and disturbance as the cost of progress, then perhaps the individual will feel no great sense of disadvantage. But generally speaking, these comparative judgments have led to an upward escalation of social demand.

Keeping the temporal and the comparative elements in mind, I should suggest that it is possible to measure the quality of life by assessing some of the variables within it, the so-called social indicators; they include the following:

—First comes *health*: the opportunity for the individual to receive health care and to have it delivered at a reasonable cost.

—A second indicator is *education*: is it possible for the young to receive enough education both to be competent in their early years and to adapt to the world of widened opportunity in which they might well live in later life? Does the learning experience continue and, if so, for how many?

—*Employment* is a third indicator: what opportunities are there for employment, and at what level? In the United States we are coping with an unemployment rate of roughly 7%; although this generates for many Americans a comfortable life, what are the prospects for the potentially or actually unemployed? If simple survival requires a twenty-four hour daily struggle, as it does for some in the United States and many in other societies, the concept of "quality of life" becomes irrelevant.

—Another indicator is *leisure time*. Privacy, mobility, the opportunity for recreation are frequently associated with a relatively higher level of development.

—*Command over goods and services* is also important. Although quality of life is only partly to be measured in material terms, clearly access to the products of the society matters to the individual. If the life-span lengthens, will quality be maintained to the end?

These are but a few of the building-blocks which together constitute the concept of quality. It is worth noting how many of them have an energy component. For example, you will not get the trend of employment levels usually deemed desirable unless you have available energy. You will not get the housing required unless your energy base is satisfactory. The availability of goods and services, the material return usually associated with more advanced levels of development, all of these and more are tied to the amount and the cost of energy.

In America, as in other societies which are fortunate enough to have developed a certain degree of industrial capacity relatively early, the relationship between energy and the quality of life has always been a reality. It was waterpower and the steam engine that made it possible for us to have the cheap cotton textiles of the 19th century; the steam engine on boats and locomotives permitted us to make the most of our rivers, to crisscross the continent with a dense railroad network, and to build a truly efficient national market. The automobile did for us just what Henry Ford said it would do in 1909: make it possible for every man "making a good salary" to "enjoy with his family the blessing of hours of pleasure in God's great open spaces." Ford may not have had the C-B in mind, but it was accurate forecasting nonetheless. For the internal combustion engine changed America: cities proliferated into suburbia; the family altered as the children moved from the porch swing and parental control to the Model-T and relative independence; bank-robbers profited; ministers began to complain of empty pews; some would go so far as to assert that Henry Ford's invention produced a secularized America.

As with the automobile, cheap electric power revolutionized American life. When a richer America curtailed immigration, and when the availability of workers in private households declined, there was electricity to help the hard-pressed housewife with washers and driers, electric irons, vacuum cleaners, re-

frigerators, and frozen food; the beleagured middle-class was rescued by consumer-durables. Along the way, as we all know, our rising average real incomes were sustained not merely by an expansion of the energy available but a switch from wood and wind and horses to coal and oil and gas. To be sure, problems arose with time: the all-electric home, once praised as the ultimate in convenience, made sense only at a time when electrical energy was cheap; it makes less sense in 1976.

I have stressed the automobile and electric power deliberately, since they changed the contours of the American 19th and 20th centuries. With a few exceptions, Americans assumed that cheap energy would last indefinitely. Many of the classic works about America that bear on the quality of life are based on this assumption. For example, the distinguished historian David Potter, in a book entitled *People of Plenty*, argued in 1954 that the American character was a by-product of economic abundance: land, wealth, energy, power, etc. The assumption of continued abundance, thus, was built into the American mind and shaped our attitudes. Other critics have pointed out that from the 17th century on, Americans enjoyed a fortuitous patterning of natural resources: the commodities needed for trade were ready and waiting for the arrival of settlers. From the fish swimming offshore in the Atlantic; from the timber that grew to the water's edge; from the beavers in effect waiting to be turned into millinery; from the progressively richer soil as settlement moved inland; from the Mississippi available as a funnel into the world market, one could turn to the inevitable happy ending: gold waiting in California. It was as though it was ordained for America to find the commodities needed for industrial growth in this extraordinarily rich continent. The happy discovery of petroleum in Pennsylvania gave us one more reason to believe that we were atypically blessed.

II

It was left to the world of the 1970s to realize that America was less atypical than she had believed. In 1973 it was easy to assume that the transition from abundance to scarcity had in effect come about overnight. Of course, the finite nature of our oil and gas reserves had been realized earlier; but this realization was not widely disseminated. The 1970s have therefore been a period of reassessment, a time when the crisis was not only economic but political, psychological, and even moral. Because as a country we are apt to take a giant swing between optimistic and pessimistic moods, the oil crisis of 1973 precipitated a sense of self-doubt and concern about the very survival of American civilization as we have known it. On the one hand, the environmentalist pointed to the cost of using energy—the impact of pollution and other negative by-products—coming to the conclusion that perhaps we would be better off if our energy base dried up. Facing the environmentalist, the energy advocate argued that environmental sacrifices had to be made if we were to maintain a quality of life satisfactory to the majority. This argument may have been unusual for Americans; for other societies it was, however, a familiar confrontation.

It is easy and even fashionable to denigrate the kind of life that we and others have built on the basis of an energy-intensive industrial technology: traffic jams and smog, the dreary architecture of suburbia, polluted waters, and the frustrations inherent in the kind of bureaucratic institutions required to cope with the interdependent society which has emerged over the past two centuries. Considerable good came out of this criticism, which was especially intense among the young affluent whites of America in the 1960s. They were not alone, but they certainly helped strengthen the movement for control over air and water pollution, and raised important questions about the quality of life even if they could not immediately find stable and satisfying answers.

But they missed, I think, the extent to which the quality of life for most human beings had been greatly improved by the material progress achieved in the United States and elsewhere. It was that material progress which not only made possible more and better food, medical care, shelter, and clothing; but as indicated above, it also widened educational opportunities, opportunities for travel, and, in the largest sense, the opportunity for human beings to fulfill to the maximum their inherent talents. Only those who do not know how hard and narrow life could be on a small preindustrial-age farm can deplore the advantages of modern capital- and energy-intensive agriculture. Only those who do not know what an industrial slum was like can ignore the improvement in the quality of life

that the movement to suburbia and a family car could bring about.

Moreover, both within the rich industrial societies of the world as well as in what we call the developing countries there are, literally, several billions of men and women who do not now enjoy the amenities that an industrial civilization can provide. They are determined to achieve them. Any realistic prescription for future policy should take into account that determination to seek a better life. In my judgment, these aspiring peoples are right to try. It is wholly proper that we should devote substantial resources to assure that our air and water are clean and that we be prepared to pay a significant price to preserve the landscape, our beaches and parks, and natural species. But, as I look at the human condition here and abroad, I do not believe in zero economic growth. Some day that may be the right policy for the United States and the human race; but right now it is an unrealistic and elitist position.

III

But if we and the world are going to continue to grow, we shall need for some considerable time a regularly expanding energy base. And, if I understand correctly what the energy experts tell us, we must continue to expand that base while recognizing two hard facts:

> —We have something like a quarter-century to find a new energy source to replace, substantially, oil and gas.
>
> —Although there are ample energy resources available for this quarter-century, they are liable to provide energy only at a higher cost than we have known in the recent past.

If this view is correct, a great premium attaches not only to finding a virtually infinite and non-polluting substitute for oil and gas but also to learning how to economize and to use energy more efficiently. There is, I take it, no need for us to become poor; but there *is* reason for us to expect a quarter-century or so of relatively high-priced energy, when a bit of care and even austerity with respect to the use of energy might be appropriate for our society.

If we look beyond the field of energy, the challenge of the next quarter-century turns out to be even more substantial. This is the generation in which we shall feel most heavily the effects of the rapid rates of population increase in the developing continents. This is the generation when tension between the supply and demand for food in the world may be most acute. This is the generation in which some of the poorest and least developed parts of the world must move forward and acquire the capacity better to shape their destiny for the longer future.

These challenges in population, food, and development all relate to energy. Right now, for example, the agricultural experts tell us that the chance that the developing nations can close the gap between food demand and food supply and feed themselves depends on increased applications of chemical fertilizers. These are products of energy. Right now a good many of the developing countries cannot afford either to buy chemical fertilizers or to commit themselves to build chemical fertilizer plants at the present price of OPEC oil. We know, for example, that there is an important inverse relation between birth rates of developing countries and the pace of economic and social progress. It is the fact of economic and social progress perceived in the life around them that, in one way or another, leads husbands and wives to have fewer children. Right now, economic and social progress in the developing continents has been slowed down or frustrated in the wake of the energy crisis of the last few years. There is still another important connection between energy and development. The energy crisis of 1973–74 threw North America, Western Europe, and Japan into the sharpest recession since the 1930s. Recovery is under way and we all wish it well; but the economists agree the recovery is likely to be weak and incomplete and that we are to expect unemployment in the United States not much lower than 7% in 1977 as well as 1976. If this is true in the United States, it is unlikely that Western Europe and Japan will regain their momentum of the 1960s. I underline this point not only because it bears on life in the advanced industrial societies like our own, but also because the pace of economic and social progress in Latin America, Africa, and Asia depends on the momentum in the rich northern part of the world.

IV

If we are all to go forward, then, in an era of relatively high-priced energy and cope also with the great chal-

lenges of the environment, population, food, and development, we, as Americans, and we, as an industrial civilization, face a challenging agenda.

—We must get ourselves back to full employment not by expanding the production and sale of big cars and other energy-intensive durable consumers goods but by increased investment in energy, energy conservation, insulated housing, mass transport facilities, agriculture, and research and development.

—We must concert our policies with Western Europe and Japan, not only in energy, but also to help bring about a long-term understanding with the oil producers—an understanding that is only likely to be possible if OPEC decides that the energy importers have adopted a serious energy program.

—We must try to work out a policy in which the industrial nations and the oil producers help the developing nations resume rapid economic and social progress and, especially, increase their agricultural production so they can feed the populations scheduled to be born.

—We must mobilize our best creative talent, not only to find the new energy source that will sustain us in the next century, but also to increase our ability to save energy and to produce food more efficiently.

—And, even more important, perhaps, we shall have to find the political leadership and wisdom to overcome, at home and abroad, the schisms inherited from the past generation, so that we can rally as a nation—and, if possible, as an international community—to accomplish these things together. With all due respect to the world of science and technology, I believe the outcome is going to depend rather more on my field, rather than on most of yours; that is, the greatest challenges we face are in shaping our political and diplomatic life around the new agenda rather than going on with the attitudes, postures, and debates of the 1960s.

V

As a teacher and university administrator, I cannot be a pessimist on this score. In The University of Texas at Austin, for example, there are over one hundred members of the faculty offering courses in the range of problems we group together under the heading of Resources and the Environment. You all know of the distinguished research going forward here in the field of energy; but men and women in the Population Center, our area study centers, our natural and social science departments, are also engaged in major efforts bearing on the new agenda. Perhaps most important of all, our students, with a sure sense of what lies ahead, have thrown themselves into the study of these matters with determination. They now know the image of automatic easy affluence, accepted only a few years back, was an illusion; but they exhibit every sign that they intend to try to solve the problems before us rather than permit their generation to be overwhelmed by them.

VI

Now a final question: Must the quality of life in the United States be diminished as we confront a time of relatively expensive energy, worldwide pressures on the food supply, and the strains of time when we must pay the price for clean air and water?

I began by saying that, by and large, the quality of life was enhanced by material progress as we have known it over the past two centuries. Does it follow that the quality of our life will be diminished if our cars are smaller and we have to concern ourselves with ways to economize energy and, perhaps, food?

I think not; but there are certain conditions we shall have to meet if the quality of life is to continue to improve in the face of these constraints.

First, we shall have to get back to full employment and regular economic growth. With our current levels of unemployment, something like 12½% of those 16 to 19 years old are out of work, about 18% of nonwhites. Unemployment insurance and food stamps are better than unrelieved poverty and hunger; but morale in America is not likely to be good so long as some 7 million Americans are told, in effect, that the society does not need them. Moreover, with 7 million unemployed, our welfare rolls are enlarged, our tax flows to federal, state, and local governments are diminished. The quality of public services is, thereby, reduced. If we are to avoid a real deterioration in our society, we must break the grip of stagnation we have already known for three years.

Second, we know from past experience that good morale can co-exist with a degree of austerity and belt-tightening. But it can do so only under these circumstances:

The initial requirement is a sense that the nation's leadership has faced the problems we confront as a

community and has formulated adequate programs, with a reasonable chance of success.

Next then, is needed a sense that the burdens and sacrifices these programs require are equitably shared.

Last, a sense must exist among individuals that, by their own actions, they can contribute to the success of those programs and are therefore participants in shaping their own destiny. Important in bolstering this participatory feeling are some quality-tied activities which can go forward despite high-priced energy. There is no reason, for example, that we should not be prepared to enlarge public outlays for symphony orchestras, opera, the theater, and to improve the quality of education. There is no reason why national parks should suffer, nor the National Endowment for the Humanities. These are easy targets, however, in a period of belt-tightening.

All of this adds up to the fact that, thus far, the energy crisis *has* reduced the quality of American life. It has brought about a painful convergence of severe unemployment and inflation which, in turn, has reduced the quality of public services. It has been dealt with in ways which promise no solution, ways which also bear disproportionately on the poorest groups in our population (and the poorest countries in the world) and which do not permit us a sense that we can act effectively to set things right. In the face of the energy problem and all its ramifications, we lack a national sense of direction as well as a public policy. Morale has thereby suffered.

The burden of my argument is that this need not go on. We have been rendered a little less rich by the rise in energy prices, but we need not be poor or cease to grow or cease to improve the quality of American life. What is required is clarity about the agenda we face; a crystallization of the nation's will to get on with the job; and a translation of that will into our political life.

It is, I take it, to contribute to those purposes that we have gathered at this conference.

Discussion

Question: What is your reason for arguing that each nation make sacrifices because it believes in its own national government, whatever form it may take? For instance, Americans make sacrifices for what they believe in as a democracy, France believes in its form of government by vote of the people. Therefore, they are willing to make more than average sacrifices to support their own system. No one form of government can rule the world. Even the United States has a hard time. Do you agree?

Rostow: I believe that the world has to be made safe for diversity. I think the history of the 20th century makes it imperative that we accept such diversity. By this I mean political diversity, economic diversity, religious diversity, and diverse definitions of the concept of quality of life. I think we can live comfortably in such a world as long as we do not seek domination or attempt to achieve identical results throughout.

In my mind, nothing is further from a satisfactory definition of quality of life than a homogenized globe. However, there is little chance of that occurring. What we see, on the contrary, are different patterns emerging on different continents. Accepting the world of diversity, we must realize as Americans the validity of the aspiration of lesser developed countries to explore on their own terms what a larger use of energy might mean for them. If you regard the advanced industrial societies as a club in which at the moment there are quite a few disabused members, you must still realize that some outside the club might wish to join even after becoming aware of the high price of admission. There is something uncomfortably patronizing in our saying to those who have not yet industrialized, "It isn't really worth the price. All you will get is polluted waters, corruption, and urban blight. You would be well advised to remain in your happy preindustrial situation." Such a didactic position smacks of elitism. Avoiding such an attitude, however, does not mean that we should close our eyes to the need for cooperation in a pluralistic world; the problems that we share (food, population, energy, etc.) are not monopolies of any level of society or any continent, and they will continue to be the problems of the appreciable future. What for example should be public policy at the time of the next great famine? What should be the attitude of food-exporting nations during such a crisis, particularly if it should strike at a moment when food reserves are low? It is this imperative of shared responsibility that the late 20th century has given to all of us. Global interdependence, involuntary though it may be, will ultimately produce a universal energy crisis for the temporarily over-endowed as well as for the under-endowed.

Question: Professor Rostow, you have argued that in our present society there is a lack of leadership. Which political mechanisms, which changes in government, are to be accomplished in order to start with the necessary work that has to be done?

Rostow: Achieving the kind of political leadership which will help to solve the energy equation is one of the hardest questions of all. In American terms, leadership has frequently been generated most readily to bear on a crisis; thus the first problem is to identify the situation as a time of crisis. Then public support for what often amounts to drastic actions must be mobilized. One of the explanations for the success of Franklin Roosevelt in the '30s lay not only in the universal appreciation that a crisis existed but widespread willingness to innovate toward the solution of the depression. At present, the energy crisis does not make very good politics. On the Democratic side, the definition of what a good energy policy should be is made more difficult by the fact that a Democratically controlled Congress has not come up with a workable energy policy. Nor has the President provided the answer. Other issues, thus, would seem to have more political mileage for both sides. However, for the person who will be inaugurated in January of 1977, there will remain a real energy challenge; it is more than likely that during his administration energy problems will again be in the headlines. You cannot avoid the world food problem; you cannot avoid the problem of possible famine; you cannot avoid the impact of population pressure. When these problems surface in the years ahead, the question of the capacity of the President and the Congress and the State Governments and the beleaguered mayors of American cities to generate public policy will again be

tested. A crisis is a performance-accelerator but it is unlikely that there will be much action in *advance* of crisis. I seem, thus, to be in the dismal position of saying that things have to get worse before they get better. Meanwhile, we are going through that fascinating national exercise which is a Presidential election. The problem at the moment is that there are too many other issues which have more political appeal, so that the energy crisis is pushed way down in the hierarchy of candidate concerns. (This is a splendidly bipartisan comment, by the way, because it applies to every known candidate. The list may be getting shorter, but it applies even to those who have disappeared from the list.)

Question: The United States represents 6% of the population of the world and consumes 30 to 40% of the world's goods, and this does not seem morally correct. I wonder if you would spell out in more detail how we can conserve energy and cut down the use of world resources.

Rostow: The first answer has to be conservation. In housing, for example, more attention obviously needs to be paid to questions of insulation, solar heating, etc. In respect to the internal combustion engine and its uses, we have a long distance to go to solve the problem of cars themselves and to move seriously in the direction of mass transportation. Clearly the nearly empty cars on the American highways offer no solution to the energy problem. Then, in terms of alternate sources and new technology, we need to look very seriously at the trade-offs involved. We have in this country more than four times as much coal as the Middle East has oil, and a good part of it is either not usable or desirable under present environmental standards or in terms of present technology. Seeking alternate energy resources is clearly a part of the U.S. agenda for the next quarter century. We should turn our attention to these matters without a sense of deprivation or self-pity. We remain on the very short list of potential food exporters. Our living standards remain relatively extremely high and our alternate energy sources give us options not open to all. Even though conservation and alternate energy sources have little immediate political appeal, it is worth realizing that an alternate cost to the world might be measured in violence. The rightful resentment of those peoples who in times of high energy cost have no capacity to grow needs to be made comprehensible to Americans. There is no reason for us to remain both singularly favored and indifferent while others are not in a position to enjoy even the rudiments of a good life. It is true that the gap between our one-time preferential position in respect to energy and the position of a large part of the world has now lessened. Yet it is still a time when Americans can practice what I would call energy-leadership, thereby assisting both ourselves and the world of which we are inextricably a part.

Energy and Food Production

Mr. C. W. (Tex) Cook
Former Chairman of the Board of General Foods Corporation

We have expended a great deal of *energy* in the last few days *talking* about energy.

The discussion has produced a great deal of helpful light, but—so far—we have not dealt with the source of the *human* energy that makes a meeting like this "go," that indeed makes this world of ours "go."

By that I mean the food supply. Perhaps because food is considered a renewable resource—within limits—there seems to be less concern about the impact of the energy situation on food supplies and prices than many of us in the food industry regard as warranted.

If the conversations I have heard across the U.S. during the past 2½ years on the subject of "Energy" are representative, the typical American's concerns in this area rank in descending order as follows:

1. Will I be able to get the gasoline I need (read that "the gasoline I want") for my car or cars?
2. Will I be able to get the natural gas, fuel oil, or electricity to warm and cool my house or apartment satisfactorily?
3. Will I have to pay significantly higher prices for gasoline, natural gas, fuel oil, butane, and electricity?

—We in the Austin area already have an unwelcome answer as far as natural gas and electricity are concerned.

4. Will my company be affected adversely to such an extent that my job may be in jeopardy?

And then, at least this far down the line of concerns:

5. Will the prices I must pay for food be affected significantly, and will I have to reduce the frequency that we can have good steaks on the table?

Not even represented on that list is a sixth item:

> What will be the impact of diminishing supplies and ever-higher prices of petroleum and its products on the availability of food for the hungry masses in the less developed areas of the world?

My purpose this morning is to review with you the question that many qualified observers believe should be at the top of the priority list of long-term concerns, to wit:

> How will the energy problems of the future affect both the supplies and prices of food:
> (a) in *this* country? and
> (b) in the chronically undernourished countries?

Permit me to submit three conclusions I believe will prove to be valid:

> 1. The United States will continue indefinitely to produce more than enough food to meet this country's needs. But,
> 2. Prices of our food will continue to increase at a disturbing rate long term—both in absolute numbers and in relation to other prices.
> 3. The terrifying task of trying to erase hunger in the so-called Third and Fourth Worlds will become still more difficult—even more people are going to face famine.

Let's focus attention on this country first. Few of us have taken the time to reflect on the dramatic changes that have occurred in agriculture and food processing since World War II. Most manpower and animal power on our farms have been replaced with energy inputs in the forms of sophisticated expensive machinery, fertilizers, pesticides and herbicides, irrigation, and lots of fuel energy—in addition to that primary source, solar energy, which is bestowed so bountifully on our land.

As one authority phrased it:

> The principal raw material of modern U.S. agriculture is fossil fuel, whereas the labor input is relatively small—about 9 man-hours per crop acre . . . .crops production costs will soar if and when fuel costs increase two- to five-fold over the next 10 to 15 years, as many experts predict.

While Americans understandably boast about the exceptional productivity of our food system, little attention has been devoted thus far to the decreasing efficiency of that system based on the ratio of energy input to the energy equivalent of output. For the sake of comparison, consider that "primitive" cultures often achieved as much as 50 food calories for each calorie of energy invested. Industrialized food systems, such as ours, require as much as 6 to 10 calories of energy input to obtain one food calorie. Specifically, the 1970 calculation for the U.S. was 7.7 input for 1 calorie on the table. A relationship of 10 to 1 is probably more accurate in 1976.

Our total food system from farm to table consumes from 12 to 17% of *all* U.S. energy input, depending on which estimate you accept. Based on a study by Booz, Allen, Hamilton for the Federal Energy Administration, dated December 1, 1975, the higher figure—17% which is greater than most previous estimates, is probably more inclusive; e.g., it considers such elements as use of consumers' vehicles to and from retail food stores, as well as restaurants, clubs, etc.

Of this total energy input for our food system, approximately one-fifth is accounted for by farming and farm-support activities. Almost 2 calories of energy are invested at the farm level for every single calorie of farm products available for use.

Before moving on from farms to food-processing plants, let's consider what our insistence on a meat-based diet does to energy requirements. As has been widely publicized, meat consumption per capita in this country approximates 250 lbs. per year. To give some idea of the magnitude of the activity required to produce this much meat for our tables, in physical mass the livestock population in the U.S. outweighs the human population by more than fourfold.

Ninety percent of the cereal, legume, and vegetable protein suitable for *human* use is fed to livestock to produce our animal protein—meat, milk, eggs, cheese. (Incidentally, in addition we feed our 100 million pets—mostly cats and dogs—and 8 million horses, pretty well too. But, of course, anybody who *dares* to question the importance of a household pet is looking for a fight.)

The "bottom line" to me is that 1 lb. of *animal* protein on your table requires that 5 lbs. of *vegetable* protein be fed to livestock. And, as you would expect, the

more we insist on grain-fed choice and prime beef, the greater the inefficiency of the total system.

Food processing and packaging require more energy input than farming operations—65% more according to responsible estimates. Responding to the public's demand—or desires—to have more and more built-in "chef service" and "maid service," and the increased amount and complexity of packaging such convenience foods, have multiplied the energy requirements. Examples:

—"heat and serve" complete dishes or even complete meals

—seasonal fruits and vegetables frozen, stored, shipped, and retailed at zero degrees F., so that all areas of the country can purchase an item 12 months of the year

—dehydrated or "instant" potatoes, milk, coffee, and other items.

I feel certain most of us, especially housewives with jobs outside the home, regard such developments as great progress, and the advantages are obvious. The time made available for other purposes by these "convenience" foods is very valuable. The fact is, however, that each additional refinement calls for extra energy input. As an example:

—canned potatoes use 44% more energy per lb. than potatoes offered as "fresh produce"

—frozen potatoes require 66% more energy than canned potatoes

—dehydrated potatoes use up 78% more energy than the frozen product, or over *4 times* that of fresh potatoes.

It is recognized, of course, that all methods for preserving perishable foods—with the possible exception of sun-drying—require some "energy input." Frequently, the end result is better values for the consumer. Three examples:

—non-fat milk, a by-product of large-scale butter production, is often in surplus supply. Result: dehydrated, or powdered milk, is normally available at bargain prices vs. liquid milk.

—misshapen, very small, and/or surplus potatoes, are entirely suitable for dehydrated or "instant" potatoes. Result: this convenience product is often cheaper per serving than fresh potatoes.

—coffees, grown at low altitudes in Western and Central Africa, are generally considered inferior to coffees from Brazil; and, *especially*, when compared to the high altitude varieties from Colombia, Mexico, Central America, Kenya . . . etc. . . . However, African coffees are well suited to the dehydration processes employed to produce soluble or "instant" coffees. Result: lower prices, relatively, to consumers.

Similar comparisons could be made for many processed and packaged foods. The plastics alone used in food packaging with today's emphasis on wrapping individual portions impose an increasing drain on petroleum-based raw materials.

To round out the domestic food-energy relationship, it may be surprising to some to hear that *preparation* of food for consumption utilizes almost as much energy as farming and food processing combined. Of the estimated total energy input to our food system, it is calculated that *26%* is accounted for by in-home preparation, *18%* for away-from-home preparation, e.g., restaurants, hospitals, schools, etc.

Could significant reductions in energy usage by our food system be achieved, and what are the prospects? Yes, major savings *could* be made, but I, for one, doubt if we will turn back the clock and calendar enough to make much of a dent in overall energy demand. I believe Americans will continue to assign a high priority to the maintenance of high farm productivity and the availability of a wide variety of high-quality nutritious foods with built-in convenience, even if higher prices are inevitable.

But, energy savings of large magnitude *are* possible. For example, on the farms:

—make greater use of animal manure from feedlots; decentralizing feedlots could aid such a trend

—revert to more crop rotation, plowing under so-called "green manure" crops to add nitrogen to the soil

—accept lower yields per acre on some crops by reducing nitrogen fertilizer applied

—use more manpower to replace some of the mechanization

—reduce substantially the amounts of grain fed to livestock

Similarly, if food processors and distributors planned their operations primarily to minimize energy consumption rather than meet the wishes and expectations of consumers, many changes would be possible, such as:

—minimize certain frozen food operations
—eliminate, or greatly reduce, dehydration of those foods that are not highly perishable; e.g., coffee and rice
—eliminate those refinements that are primarily for convenience whenever the energy input required exceeds that saved in consumers' kitchens
—eliminate that amount of packaging intended for cosmetic purposes
—use reusable containers for high-volume items, especially for soft drinks and milk

Actions by consumers could result in major savings of energy in our food system. A few "for instances":

—reduce meat consumption significantly
—choose grass-fed beef and/or more energy-efficient animal protein (chicken is more than twice as efficient in converting grain protein to animal protein as compared to grain-fed beef or pork)
—increase consumption of those fruits and vegetables grown in each consumer's immediate vicinity (as fresh produce)
—reduce consumption of distilled spirits, certain brews, and soft drinks
—shop less frequently; purchase in larger quantities
—reduce amounts of *usable* food thrown out with the garbage (University of Arizona study)
—reduce overall food consumption by the 1/3 of all Americans who are overweight

To repeat, it is my opinion that such austerity moves would be very difficult and slow, and—if forced in any fashion, including rapid increases in prices—one predictable result would be much political flak.

Turning from the domestic scene, we are confronted with overseas demands for certain of our grains and oil-seed crops. Some of this demand gives us much comfort and benefit; some, much anguish. In recent years, overseas sales of U.S. agricultural products have accounted for approximately 20% of all of our exports—over $20 *billion* annually! A great boon to our economy, to our balance of payments, to the health of our agriculture! As U.S. imports of oil and other petroleum products rise, food sales abroad become increasingly beneficial.

It is important, therefore, that our farm production remain high, our crop quality up to desired standards, our prices competitive in the world market and still yield a fair return to our farmers.

At the same time, the spectre of increasing hunger throughout many areas of the world confronts the so-called "developed" nations with threats to world health, world peace, world economic progress, and to the conscience of each of us as individuals. Time does not permit detailing what most of you already know about the losing battle between population growth and food supplies in those disadvantaged areas of the world.

Suffice it to say that any near-term measure to increase either the production of food or the efficiency of its utilization will be inadequate in the longer term until some method has been found for dealing with the population problem.

Although, as Secretary Butz put it rather grimly, if the world can't feed 7 billion people in the year 2000, the world won't *have* 7 billion people in the year 2001.

But even near-term improvement is threatened by the realities of the oil and gas outlook which have been set forth during this Conference. What many have considered the one great hope—the so-called "Green Revolution" approach to greater productivity where the food is needed most—has been dealt a severe setback.

To accomplish the two-, three-, and even fourfold increase in yields for rice and wheat—especially in parts of Asia—has called not only for more productive seed strains but relatively larger quantities of nitrogen-based fertilizer, fuel for irrigation wells and pumps, herbicides, and pesticides. Prices for these items have reached levels that made what has been a bleak outlook for these food-short nations even more ominous.

It should be noted, however, that agronomists in the U.S. and in some other nations that are trying to aid poor countries grow more of their own food, *now* realize that our energy-intensive mode of agriculture is just not applicable in those areas.

Fortunately, progress has been made in developing simpler farming techniques that make greater use of manpower, which is usually available in abundance.

Even before the energy crisis hit the world scene, there was increasing evidence that this country was getting frustrated, was losing patience as a result of what we regarded as a very poor response to years of significant efforts by the U.S. to alleviate hunger in several countries. There is reason for disappointment in that too few of these less-developed nations have clearly assigned top priority to the objective of becoming more self-sufficient in food supplies for their people.

By contrast, whatever we may think of Mainland China's society and form of government, all of the evidence I have been able to muster indicates that they have managed to provide adequate nourishment for some 800-plus million inhabitants. My information is that they give top priority to food production and distribution. Even more disappointing and disturbing, long-term, is the lack of significant progress in controlling the rate of new births in the very countries that were getting huge quantities of food-aid shipments from this country.

Obviously, this is a sensitive area but it is hard to argue with numbers. With growth rates that could double population in less than 25 years in some of the poorest countries, it is understandable that some specialists in this field are concluding that current and prospective petroleum price levels may well be a devastating blow to the already faint hopes for a solution.

I think the long-range prospects are summed up very well in a paragraph of an excellent article in a publication of the American Association for the Advancement of Science by Drs. John S. Steinhart and Carol E. Steinhart:

> Food is basically a net product of an ecosystem, however simplified. Food production starts with a natural material, however modified later. Injections of energy (and even brains) will carry us only so far. If the population cannot adjust its wants to the world in which it lives, there is little hope of solving the food problem for mankind. In that case, the food shortage will solve our population problem.

I think the "net" of what I have tried to convey this morning is that petroleum and certain of its derivative products are essential in providing Americans with the kinds of food they want and need for our "way of life"; and essential if food for even bare subsistence is to be available to as much as one-half of the world's population in the years to come.

Discussion

Question: What you say about the inefficiency of grain conversion to grain-fed beef is certainly true. But the other side of the question probably should be exposed. What do we do with the grain if we do not feed it to the animals? Who pays for it, where does it go, what about the farmer?

Cook: Well, obviously, that question does come up and the point has been made that much of the acreage that now produces food that is used today solely for animal feed is not necessarily adapted to the food that we're accustomed to. Much of it is. As you know, there are some trade-offs, e.g., soybeans instead of corn. Some nations are eating high-grade sorghum today. I don't have a perfect answer for it, but some friends of mine who are farmers tell me they could make quite a few changes in terms of what they raise on their acreage, if we did feed less grain to animals. I'm not necessarily advocating this, I'm simply saying it would be technically and theoretically possible, even if some of this land lay fallow or were used for food crops less efficiently.

Question: As you indicated, agriculture is certainly one of our greatest American success stories. Underlying this entire Conference and many of the issues of public policy these days is the question, what should be the role of government and what should be the role of the private sector? It would appear that American agriculture has been a very happy combination of both the private endeavor and government endeavor over a very long period of time. I wonder if you would comment on that, and maybe suggest what that experience might suggest for other problems, particularly in the energy area that we have been dealing with.

Cook: Yes, many are not aware that one of President Lincoln's great contributions, at least that of his administration, was the development of the land grant college system that has led to our county agents, our agricultural experiment stations, so that we've been working at this some 110 years. These days great cooperation is required between the governmental sector, the academic sector, and the private sector, and how to get this across, how to accomplish it, in some of these disadvantaged countries has been quite frustrating. I'm encouraged by the nine agricultural institutes that have now been established throughout some of the developing countries. As you probably know, these are financed largely by what is called the consultative group, but the U.S. plays a very, very important role as do a few other countries, the World Bank, and certain foundations. It's going to take a long time to catch up and whether it can be accomplished in other parts of the world in the quarter of a century that Dean Rostow referred to, this probably is the big question.

Question: You said the value of exported food last year was 22 billion dollars, do you have any idea of what the value of imported petroleum required to produce that food was?

Cook: I'm sure that someone here has that figure right at their fingertips. I'm told that according to the most recent figures we are now approaching 45% of all our oil being imported. Whether that was a peak month remains to be seen but the direction of the curve is frightening. I don't have the exact dollars in mind, but the overriding fact is that the U.S. in 1975 enjoyed a favorable balance of payments, primarily because of agricultural exports.

Question: I would like to thank you for a very informative speech. And I would like to ask you how about developing food that uses less energy and less water, since water is a source of energy or used to be. And you were talking about the results of University of Arizona, about the food that's been thrown away in the trash. How about re-using this to feed our animals, to reduce the animal protein that we need for our daily lives, instead of feeding them top-choice meat. After all, we go to restaurants and we ask for a doggie bag; you know in some restaurants now they call it a people bag.

Cook: Well, to take your last question first, I had the experience, and I'd say the advantage, of living on a farm during World War I when my father was overseas. I guess you'd call it a form of subsistence farming. We always had two or three hogs that were fed nothing but scraps from the table. They did very well and provided pork in the fall; we didn't have refrigeration, so we had to be very careful how we used it. On the matter of concen-

trating on foods that use less energy, here again there are trade-offs I'm sure. We have to ask ourselves if they are acceptable. For example, in this country meat-like products that are derivatives from soybeans, called soybean isolates, are increasing slowly in popularity, and I submit that over the next several years we will see great growth in such projects. Now this would reduce petroleum usage, but the processing takes a lot of electrical energy. Did you have any particular products in mind that would be very useful, let's say in your country or other countries, that would take lower amounts of water and lower amounts of energy?

Question: That's what I wanted to ask you, for some products that use less energy, thank you. Part of my question also was to ask you what products in particular would use less energy.

Cook: Well, for example, soybeans compared to corn.

Question: But would it be acceptable for us?

Cook: I don't know. Soybeans are very popular in the Orient; Americans just do not like the taste of soybeans. We use the soybean oil and we use the soybean meal, but we don't like the taste of soybeans.

I guess people must set their own level of acceptance. They can accept whatever they want. I believe that people nowadays have to set their own patterns, what they want as a *minimum*. So we have to work on this and accept some changes if we want the human race to keep going on.

We learned early in World War II, in the invasion of North Africa where we disrupted their farming operations and many people were said to be starving. We in the food business were asked to quickly produce some product that could be transported, that would be rich in protein, and easily prepared. We settled on dehydrated split pea soup, and produced it by the thousands of tons. Unfortunately, the North Africans didn't like it; they preferred hunger and it just sat in the warehouses and rotted. Severe changes in diet pose a real problem.

Rostow: May I just make a comment on this. There have been changes in taste in America. While slavery still existed, Maryland slave owners were forbidden to serve their slaves oysters over once a week because it was considered a punishment that the slaves should have to undertake. At the same time we are using sturgeon for fertilizer on the grounds that the sturgeon itself and those nasty eggs inside were best used simply to fertilize the soil.

Cook: We should learn how to beef up the protein value of pizza, and perhaps it will take the world over the way it has the American youth movement.

Question: I'm a student here at the University, and I would like to know in regard to the consumption habits of Americans, do you feel that through advertising policy and marketing promotional policies that we could change America's consumption habits in the way food is packaged and purchased through the stores?

Cook: From some years that I could show you after a 45-year period in industry, I would answer that flatly NO. We have tried time and again to market products that we thought were excellent, nutritious, were sound in terms of food value, and often we fell flat on our faces. I'm told the best way to kill a product that's not acceptable to the American public is to advertise it heavily. Now I do think that on some things that have basic merit there's been gradual acceptance. For example, over the years, I think Americans have come to regard vitamins as important and good; they don't know why, but they accept that vitamins must be good. Unsaturated fats somehow seem to be in the right direction. High and balanced protein foods, they must be all right too, even if people don't know what they are. There's getting to be a little public recognition that some essential minerals, trace minerals, are important even though scientists don't know precisely what each one does for us. But gradually, gradually, I think the answer is "yes," but not on a particular product. Oh, yes, you get some specialty products, for example, I'm thinking now of the two egg products that are on the market where most of the yolk has been removed. People with high cholesterol problems where their doctor has advised them about the products, yes. De-caffeinated coffee—Sanka, has become the third largest selling coffee in the United States,

mostly because of concern about caffeine. Doctors have helped considerably. You know what's happened to soft margarines as compared to butter, so, yes in a slow, long, gradual sort of way, but short term, no.

Question: I would like first to make one comment, perhaps you could explain it back to me later, and then I'll ask the questions. You said something about the higher petroleum prices delivering the final blow perhaps to any expectations for future development in the developing countries. I believe the question might be debatable, but I feel it would only be fair to say, too, that the high prices of equipment and goods and machinery and service and what-have-you coming from the industrialized countries has also been making a big dent into the possibilities of the developing countries, and not just accidentally, but consistently. Next question, sir. You said something interesting about China being able to feed 800 million inhabitants. I would like for you to explain a little bit more, go into details of this if you have them, and how to do it, and because we have seen the example of Russia, and Russia has again consistently been failing in their agricultural plans. That's one of the questions. The other question is that do you think that fertilizers in general will in the end damage the soils where the fertilizers are used or in any way change the ecology of the area? A more general question, should the American, should America keep on striving to obtain the highest standard of living? Should America keep striving to achieve the higher standard of living, higher level of life style, and should we, the developing countries, try to imitate you?

Cook: If I could answer all of those questions as well as they deserve to be answered, then I don't think I would be here. I'd probably ask Dean Rostow to move over, but let me see if I can even remember them. First, let me acknowledge of course that the high prices of the various items that these disadvantaged or LDC's have to import do affect their problems of raising their standard of living. I am just back from the Dominican Republic where very few things are manufactured. Virtually everything except raw sugar, tobacco, cocoa beans, and coffee have to be imported. So I'm somewhat aware of the higher prices, because I've been in their supermarkets. But to consider one country, let me take Bangladesh as an example. I was talking to a young Australian who had just spent 8 months in Bangladesh, and he said "sure, they need a *lot* of things, but what they need the most right now are fertilizer and petroleum products to grow more of their own food." So in terms of priority, I would have to, for those countries, put technical aid for their agriculture right at the top of the list.

Now in terms of whether or not fertilizer damages the soil, there's great controversy about this. I think generally it's agreed that if you do not take care of erosion and run-off and try to make up the loss of top soil by adding chemical fertilizer, you're asking for trouble long term. Therefore, if it would be possible first to control erosion, and secondly, actually to add some natural manure, you would help the total quality of the soil. But basically, the fertilizer industry has made such progress in terms of their formulations that I have the impression, and I'm not an agronomist, but I have the impression that the harm to the soil is really not a serious matter.

Now on your last question about Americans striving for higher standards of living, I'd like to refer you to Dean Rostow's remarks which I think were very perceptive and with which I am in full agreement. I think we are going to have to be much more selective in what we do. It's very tough to tell young people not to strive to improve themselves, but in terms of total society, I have a feeling that we've got to reorder our priorities. Many of the things that some of us do and have aren't very important, and to repeat I would just hope that we would reorder our priorities. Again, I would suggest that you think back to what Dean Rostow said.

Thank you very much.

Energy and International Finance

The Honorable Peter G. Peterson
Former Secretary of Commerce of the United States

I can't say I'm too comfortable hearing Tex Cook make those rather threatening observations about being overweight. Frankly, I'm surprised, Tex, at your lack of generosity since you invited me here, but I take it you were trying to dramatize your point as obviously as possible.

I thought what I would do today is spend a little time inventing some questions rather than providing too many answers to the energy riddles. I do that for a couple of reasons: First, I obviously minimize my exposure that way. Also, I will avoid my telling you more than I know and more than you want to hear. So what I thought I would do is present some questions to you—maybe go a little bit beyond that to suggest some principles that might give some of our international energy policies a little more coherence. And you notice I say international energy policies, not international finance policies. I suppose I should go a little further than that and talk about international economic and political policies.

One of the problems we all know we have had in the last few years is that our international policies are not very coherent. And I suppose it is worth spending a little time asking, "Why aren't they coherent?" Well, to start with, I guess we have what we used to call in my home state of Nebraska some very am-bee-VAY-lent attitudes toward the world we are living in. For example, at one level we have an exaggerated sense of fear. At the same time we have an exaggerated sense of our potency and our importance and our sense of hegemony from earlier periods. As an example of that: There is a story going around now about the Secretary of State—I

guess there are a lot of stories going around now about the Secretary of State—who was given some very high quality wool, as I get the story, with which to make a suit. I am sure that the wool was under the $50 diplomatic gift limit in case the press is here. And the story goes that he took this wool to the tailor in Hong Kong, who said to him, "Mr. Secretary, you're much too big. You've grown so much, there really isn't enough material here for a suit." Well, the Secretary thought it was probably due to the inefficient techniques there, so, he took this same bolt to the most sophisticated tailors in Britain, and they told him essentially the same thing. He then, the story goes, went to Tel Aviv and the tailor there said, "Did you want one suit or two?" The Secretary was rather confused and told him about his experience with the British tailors and the Hong Kong tailors, and he said, "Well, that's easy to explain. You're not such a big man in Tel Aviv any more."

It's this kind of ambivalence, I guess you'd say, about who we are and whether we are as big as we used to be, or much smaller, that helps explain I think why some of our policies do have this curiously incoherent quality.

There was a Frenchman who once said that when economics gets important enough, it gets political. And the problem I think we have, starting with this speaker, is most of us aren't very good at economics by itself. Even fewer of us are very good at economics plus domestic politics. And when we start moving into this marvelous world now of domestic economics and international economics where we hear such concepts in this field as cartels, embargoes, expropriation, nationalization, and so forth, which are essentially political risks, and not economic risks, it's clear from the simple understanding of compound probabilities that there is virtually no one in the world really prepared to discuss these problems in a coherent way.

Let me give you an example, or two or three, of this so-called ambivalence that exists in American policy on international energy. Take the issue of cooperation versus confrontation of the OPEC countries. I recall that at a time when we were supposed to be having a new dialogue with the Third World and the OPEC, one of the high-ranking U.S. members of the delegation was quoted in a television interview as saying that the objective of the U.S. policy was to break up OPEC. While we were having these so-called confrontation scenarios with the OPECs, we were very much a paper tiger, in which we spoke very loudly but carried an extraordinarily soft stick. I guess one of the aspects of confrontation with anybody is that if you are going to confront someone, certainly the minimum requirement is that you're reasonably sure that you are going to be successful. And as one explores some of our policies of recent years, such as the concept of minimum floor prices for oil, it probably should have been clear to us—if we had had a more coherent view of the kind of world we were living in—that these policies were not only conceptually unsound, but they were politically unworkable. I recall at the height of this concept of a minimum floor price for oil, meeting with a very senior official of the Japanese government privately, who I had been told was part of a so-called consumer group cooperative stance on this subject, who told me with a certain amount of terror in his heart and his eyes, that his country could never, in actual practice, support a policy like that. Importing 98 or 99 percent of their oil, they not only could not appear to be confronting the producing countries, but their domestic politics would never permit them to ever be charging their customers high prices for oil when they could import oil for less.

To give you another example of this ambivalence, for a number of months, you may recall, we refused to have a dialogue with the producing countries. And as I tried to find out why, the reasons were two-fold: Incidentally, when I was in Chicago I had a very good friend who told me there were two kinds of people—those who say there are two kinds of people, and those who don't. So, I'm a little concerned about oversimplifying this, but there was certainly one group that I observed who said, "Well, we're going to break up the OPEC, economically and politically, so why talk to them?" The second group seemed to say that the market forces are going to bring the prices down anyway, so why talk and legitimize high prices?

It was the same group, to illustrate the extent of this ambivalence, who also said that it would probably be a good idea for the consuming countries—meaning the United States and Germany—to underwrite the massive petro-debt that was taking place, and we would thereby promote what was called "solidarity" in the consuming world. If one, then, probed a bit further and

said, "Solidarity to do what?" it was alleged that this would promote solidarity with regard to these countries' views toward the Middle East. Well, this is another indication of the lack of coherence in our understanding of the new realities of the world. If the Middle East wished to apply leverage to countries that were importing 60, 70, 80 percent of their oil, there were certainly available means other than financial, such as simply not shipping oil, but that hadn't seemed to occur to us.

At another point in Washington, I was exposed to an interesting concept that we should limit the long-term investments of the OPEC countries in the United States to 5 percent of the equity investment and 10 percent of the long-term debt. When one said, "Why would you want to do a thing like that?" the answer was, "Well, if they can't put their money in long-term investments, they'll have to put it in short term?" And being anxious to see this exciting scenario unfold, I said, "And then what happens?" Well, the argument was that if you put it all in short term, interest rates would go down, and risks would go up. Breathlessly waiting for the next step in the confrontation scenario, "Then what?" And, of course, the answer was obvious: they would lower their prices. If you said, "Don't you think it's far more likely they would lower their production?" this tended to be an uncomfortable thought that many of us didn't want to deal with.

Now we also see this ambivalence, for example, with regard to foreign investment. In American politics, as you know as well as I, the payoff is usually to the politician who can play to the instinctive chauvinism in all of us. It's very desirable to have an enemy. And if that enemy is a "furriner," so much the better. They're less lovable, and besides, they don't vote. So, if you want to generate applause with regard to international finance, or energy, or economic policies, be sure to be tough on the "furriners" who have been doing us in for many years, use colorful language, and if you can use a pejorative phrase or two, so much the better. So, for example, as in the case of Vietnam, listen carefully to the accents, and if you hear some politician referring to the *A*-rab money, you have an idea of what is to follow.

So we have been sending out signals for some time with such pejorative phrases as "They're going to flood the American market, they're going to invade the market, they're going to take us over," and similar phrases. Dean Rostow, I might say that for years I've been an expert at euphemisms, and I had to spend half of this weekend trying to find out what the antonym of euphemism was, because in international economics we use words like "floods," "invasions," "cut-throat competitions" and phrases of that sort. I discovered that the word was "dysphemism." And I'll coin my own "dysphemism." As I look at the numbers on Arab-OPEC investment in the United States, I would think we shouldn't be concerned about flood, we should be concerned about a drought. For example, if you look at the investable surplus of OPEC countries in just the last two years, $42 billion; this last year, probably $60 billion; in '74, over $100 billion in total, and one looks at long-term investments in the United States, there's something less than $6 billion that's been put here, almost entirely in Treasury bonds and notes, almost none of it in long-term investments in this country, less than $2 billion in equities in this country. So, of a foreign portfolio investment in the United States of about $60 billion, something less than 4 percent of it is from the oil-producing countries.

So as part of our ambivalence, we seem to have had a policy of proposing non-solutions to non-problems. And among the non-problems that the United States faces at the present time with regard to international energy finance is the concept that the so-called "A-rabs" are about to take over the U.S. companies. Few things could be less attractive to *them*, in my experiences, than that.

Well, what is then a real life problem that we should be focusing on? And why do I suggest that our problem is less technical and more conceptual? I suspect that one of our real live problems in this country and the rest of the world is the problem of capital shortage, about which there is a good deal of debate these days. As I look at the extraordinaray energy investments in the next ten years, which seem to go up about $100 billion every six months or so, as I look at the pollution environmental requirements, where I saw the other day that just for the airlines industry alone to retrofit their jet engines to meet noise standards, they're going to have to spend a billion dollars. And as I look at the labor force that's already born that will be with us, I'm inclined very much to agree with the Council of Economic Advisors that says if we're going to meet what would seem to be sensible needs, we're going to have to

somehow increase our rate of savings in this country, or rate of investment, from about 10 percent to something in excess of 12 percent, which is really a striking change. Now there are those who say we don't have a capital shortage, and if you will read carefully the assumptions in one of the studies that alleged this, you will see that their scenario goes as follows: that our country is going to grow, that the revenues are going to go up, and we're going to have a surplus in our government budgets. When you examine the premises that underlie that, it is alleged that there'll be no new social programs or government programs, only the existing ones will be permitted to grow. Now if I were to believe that, I would also have to believe that I'm lean, hard, good-looking, and modest.

So I suspect that our objective should not be to send out lyrics and music on investment in the U.S. that are threatening. Rather, how do we look at this pool of $200 billion, or something in that range by 1980, and how do we attract it, and how do we reassure foreign investors, and how do we do that throughout the world, not only here, but abroad, so that these oil countries feel a sense of security in their investment. And I think that there is a whole field here that needs to be looked at.

Another example of ambivalence, I guess, is the American posture on energy where out of at least one side of our mouths most of us who have been in and out of public life tell us that we are living in a new interdependent world in which we are all vulnerable together. At the same time we are saying that we speak with great force about the virtues of U.S. Project Independence, so that the United States can become independent on this subject. Now, I think any person who has even a reasonably comprehensive view of the new world we are living in would have to say that energy is a global problem. And for the sake of our consumer friends and allies throughout the world who are something less than assured about our nationalistic rhetoric on oil, and for the sake of eventually putting more market pressure on oil prices, we have a lot to gain mutually by greatly diversifying the potential for producing oil throughout the world. For the United States, for example, according to recent studies with about 5 percent or thereabouts of the geologically favorable area of the world for oil, is the site of about two-thirds of the oil wells. Thus, the tendency in the world is to develop the highest cost sources of oil, while we've left less developed some of the lower cost sources of oil. For example, in India, I am told there were only 10 exploratory wells last year compared to about 7,000 in this country. And, of course, the average production per barrel was less here than there.

Another dilemma that we have to face is what is being proposed with the International Resource Bank, where a global bank will lend money to countries to develop resources, including energy. And if that country defaults or expropriates or nationalizes or something, this new bank would assume the loss. Now, this is inevitably going to raise questions about what kind of an incentive is this to the private sectors to produce oil. Are we really saying there aren't going to be any sanctions in this new world we're living in for the countries that do expropriate? So, I don't think you can have any kind of a discussion about international energy or finance, without having some vision in your head as to what kind of the new international economic order you're talking about.

Dick Gardner and I were on a program together a month or two ago. We agree one should try to get to Washington once a month or so just to establish how obsolete we have become. And the most impressive litmus test of that is to see what new series of initials has been put together. And I was astonished to hear the bureaucrats speaking at great length about NIEO. Now for those of you who are nearly as unsophisticated as I am, that stands for the "new international economic order," and what I am trying to say, that it is hard for me to think about the oil problem without having some notion in my head about what are going to be the elements of that new international economic order. NIEO is going to be very hard to negotiate, we are going to have to talk about a somewhat different system of international commerce than we have had up to now—where we talk about both benefits *and* sanctions, where we talk about both benefits and burdens, where we talk, in cruder language, of carrots and sticks that apply to all of us.

One country has to offer another country such things as markets, as capital, as aid, as access to resources, as access to labor. The question that'll have to be thought through is whether there also doesn't have to be a roughly equivalent system of sanctions for those of us in this new global economy that we speak so glibly

about, who decide *not* to live by the rules. And I might say that should apply to the United States as well as other countries.

I may get in trouble with my friend, Tex Cook, but I would argue that it is simply inappropriate for a country to express its ambivalence as publicly as we do sometimes; when at the same time we talk about an expanding and open world, and against protectionism all over the world, and lack of unilateralism, we think it's quite appropriate to put export controls on soybeans. Yet, a major customer friend of ours several thousand miles away has learned to depend on soybeans as a major source of his food. And it should have occurred to some of us, particularly those of us who overeat, that food tends to be rather important to other people as well as to us.

Another form of ambivalence on the energy problem is the rhetoric that says growing dependence on insecure sources of oil is unacceptable. Yet we somehow seem to go on not only accepting it, but becoming more dependent.

There is a lot of talk these days about the so-called Energy Independence Authority. And if you want to arouse suspicions of all types, talk to various points on the political spectrum. Ask their reactions to this proposal that roughly $100 billion would be put into special forms of energy finance. If you talk to the part of the political spectrum that approaches this problem from the left, you'll hear descriptions like these: the oil companies engaged in one giant ripoff in 1973 by forcing high prices on the American consumer. They created a false shortage—clearly a major conspiracy. Now they are expecting a second giant ripoff, the millenium of high rewards and zero risks, where the only person that will lose in these projects would be the consumer.

If you talk to the people from the right, from the more conservative, they would say to you, "My God, this is the energy equivalent of a post office. We're going to have energy socialism in America and what a terrible waste of $100 billion worth of capital. Why don't we let the market allocate this." So again, the end product of our ambivalence, in which we are dealing with a world that none of us like very much, is to sloganize it and idealogue it, and end up probably doing nothing—in a world in which we seem to like every kind of energy except the ones that we have.

Now this problem is going to require some unusual programs in my view. We are confronted with the fact that on the one hand we all agree we need new energy sources. Yet, if you look at the investments in these new energy sources from the standpoint of a rational businessman, you would find something of the following: In the first place, investments in synthetic projects like coal liquifaction, gasification, shale, and so forth, typically run $500 million to a billion dollars just for 50,000 barrels a day. This is more than the net worth of some of these companies. I guess it was the pig who said to the chicken about their relative contribution to the food problem of the world, "To you, madam hen, it is only a contribution, but to me, it's my entire existence." And I would guess that many corporations are simply going to say the risks are completely unacceptable.

If you look at the unit costs from these new energy sources, the costs of some of these synthetic oils are running somewhere between 12 to 25 dollars a barrel at the same time that oil produced in the Middle East would cost perhaps 10 to 15 cents a barrel.

So some of us so-called men of principle, living in this highly ambiguous and new world, who have said in times past that we believe in the market system to allocate resources, and certainly the vast majority of the time I do, are now presented with some good reasons for ambivalence. To say that we are going to rely on the market system in America to commercialize these new energy sources is to say that you're for doing nothing, because that is precisely what will happen. Some of us will become men of principle in the sense that Everett Dirksen from my state of Illinois was a man of principle. I was with him one day when he seemed to be showing an unusual willingness to compromise on some issue, and he said, "Pete, you may wonder whether I am a man of principle or not." He said, "Actually, I am a man of great principle. My highest principle is flexibility." I suspect that some of us who have thought in conventional terms, in what is clearly an unconventional situation, are going to have to think of new models by which some of these projects on the one hand meet the unusual nature of the problems and on the other hand are acceptable to our political system. So I would be among those who would think that rather than having the government guarantee a lot of these projects with massive guaran-

teed loans, I have another alternative I would come to, if very slowly. I would rather that the government say we will buy so much oil from such and such a process at such and such a price over such and such a period of time, and let the bidding process move in and let some risk, to the extent that it will be accepted, take over.

A final kind of ambivalence in this whole international energy picture relates to the problems of the less developed countries. Take 1975 for a moment and let us see how much of the impact of this oil problem has fallen on the third, fourth, and fifth world. The aggregate deficit current account of consumer countries in 1975 seems to be a number like $42 billion. If you look at the current account deficits of the less developed countries, they account for about $37 billion out of that 42; thus the developed countries with much larger gross national products have had to assimilate only a very small amount of this deficit. Thus, the aggregating deficits of the less developed countries goes something like this: $19 billion in '73, $28 billion in '74, $37 billion in '75. Some hope or expect this to go down in '76 but by only a few billion dollars; thus, while the OPEC countries are now putting a larger percentage of their so-called investable surpluses in the LDC countries, it might reach as much as 20 percent or 25 percent, there's a lot more they could do if they thought it was in their interest.

And here's where this country has to resolve another piece of ambivalence. We have been rather sticky in times past about welcoming what is obviously a new source of power into the world into the big leagues economically. And as Dick Gardner knows, we have been very zealous or jealous about voting rights and positions of various international institutions. Recently in reading about this international resource bank, I was rather encouraged to read that there was talk now about equal votes of various parts of the world, the oil producers, the developed countries, and the less developed countries. And there was this notion that if we were going to ask these countries to share in the solution, they should also share in the rewards of power and responsibility that go with it. What I guess I have been trying to say is the following: My experience in Washington suggests that if you are going to get a coherent set of policies you need at least two things. First, you had better have a coherent set of premises as to what kind of a world you want to build, and where your interests lie. We have had a hard time doing that as we can see by this series of highly contradictory approaches to the same problem.

Then I suspect it takes a large measure of political will, which I think is the thing that Dean Rostow was talking about with regard to the new leadership, whatever it may be, of this country, post-November, to force us to face prospectively what kind of a world we are going to be talking about in 25 years or so. So oddly enough, you might expect a banker to come to you with a whole set of technical proposals to some of these finance problems. Far from it. It would be my premise that in the same way that, as the cliche goes, war is too important to be left to generals, I expect that these problems are much too important to be left to financiers. And the program is certainly much too important to be left to verbose Wall Street bankers, which is probably the redundancy of the morning.

So, I think what I'd like, Dean Rostow, is kind of to leave this smorgasbord of questions on the table and hope that one or two of these issues I have raised is worth somebody's wanting to taste, and maybe even digest along with me.

Thank you very much.

Discussion

Question: Exactly what would you do, other than this minimum support price which you've rejected, to stimulate the private sector in the U.S. to invest in new energy sources and give them some security against the possibility that in the 1980's when these new sources come on stream they'll be faced with low cost foreign competition? How would you deal with that question?

Peterson: Let's look at the numbers for just a moment. It's a balancing act that I think all of us are going to have to resolve. As I look at the new energy sources we're talking about, there are somewhere between 4 and 5 categories that are probably near the point where a major commercialization project is needed. Now, the reason I emphasize commercialization projects is obvious. Until we know in fact that we can produce in large quantities, until we know what the price is, until we know that we know what to do about the environmental problems, we don't really have a credible alternative in the sense that the producing countries are going to believe that it's available. The kind of program that occurs to me is to take 4 or 5 of these fields, say coal liquefaction, coal gasification, oil shale, and geothermal at the very least. And I'd probably end up taking perhaps 2 of each of those. The reason I don't suggest that we take 20 is the following irony that we would find ourselves in. I'd like to see us minimize this country's investment of precious capital in very high cost and high risk projects. We could spend 100 or 200 or 400 billion if we wished in high cost projects. But it would be the ultimate irony for the U.S., in the interest of demonstrating alternatives to everyone's benefit, to end up with the highest cost of energy that anybody ever had at anytime. So my thought is that we would take some number like 10 or 15 or perhaps as many as 20 projects that we had decided were not going to be developed using the conventional price system. Rather than guaranteeing those projects, which I think will give rise to all kinds of pressures to have government regulation and operation of these projects, I would try some type of competitive bidding process that would go as follows: Suppose the government were to say we want 50,000 barrels a day of oil equivalent produced by such and such a date. We will buy that amount from you for the next 10 years and we want it from such and such a process. Will all the American consortia companies, whoever wants to do it, step forward and make a bid? I prefer a bid because I think both in the reality and the cosmetics of the fact that it is competitive, is important. I think I would make it possible for the government to have what we call in our business a put on this project where they could buy it out. The reason they might want to buy it out is after a few years they might discover the costs are ridiculous, that oil prices have come down, that the environmental costs are simply unacceptable, or something of that sort. But I think my going in approach would be for enough commercialized projects to demonstrate what the costs are and just as important, to demonstrate symbolically that there are alternatives. Because I learned at the University of Chicago that there is no such thing in life as zero risks and high rewards. And an interesting thing happens in life when you have zero risks, particularly in a quasi-public private project. The pressures are going to be enormous to have the government operate that project, and I don't think that's in the best interest of this country.

Rostow: I'd like you to be a little more explicit if you would about your views of the Energy Independence Authority. You gave us the views of the left, you gave us the views of the right, you, in a sense, indirectly answered, but would you care to make some observations about this proposal?

Peterson: The rhetoric, Dean Rostow, may be inevitable given our political system—the desire to say things in such a way that the television and other mass media can somehow sloganize it. I think the concept of independence and all it portrays is not a happy formulation. It suggests that we are not really aware of the dependence of the entire rest of the world on imported oil. One of the first things I would do, in addition to talking about what we're going to do, is come forward with some initiatives that increase the global supply of oil rather than just our supply of oil.

The second thing I guess I am in disagreement with most people on is the whole field of conservation. If you look at how long it takes you to get the equivalent of oil you're

now importing by new energy sources, you're looking at 1985 to 1995 before you know even on a symbolic basis whether you have any, and it's an enormous cost. It seems to me that conservation has a number of impressive advantages. It's much faster, it can start right now, and, as Tex Cook reminded us, we're beginning to push the 50% level on imports. Conservation is a great deal cheaper because the oil you're replacing is high cost oil. It saves our consumers valuable money. It helps us on our balance of payments problems. It helps us with the environment. Now it's become part of the political wisdom in this country, and you yourself alluded to it, that it's bad politics to talk about creating the sense of urgency and crisis about energy; that the American public is ill-prepared to come to grips with a crisis of this magnitude at this time. I am not so sure about that because I think anybody that thinks seriously about the implications of this crisis, when you stop to think of the people it brings together, I mean the environmentalists and those concerned about social programs and so forth, I think there could be an enormous coalition in this country who might decide that decreasing energy consumption would be a good thing. Now the approach one has to this depends on his philosophy. Given my somewhat more conservative credentials, I would like to rely on the price system as much as possible. But I am reluctantly coming to the conclusion, by simply looking at the numbers, that higher prices and even substantially higher prices are not effective due to the elasticities of demand having much effect or nearly the effect that some hoped for. So we're proceeding to get much more dependent. Now a second problem with relying entirely on the price mechanism—besides the fact that it's highly ambiguous and may not work—is that it's politically unacceptable. If any of you have any trouble believing this, talk to a working man in a labor union and have him give you his perspective of the concept of conservation through the price mechanism. He'll tell you that what you fellows are saying with all sorts of rhetoric on freedom is that you fat cats go along consuming as much as you want because you have the income to do what you want, and the impact of conservation will fall on those that are a good deal less fortunate than you. In other words, politically there is not sufficient burden-sharing in the concept of relying entirely on the price mechanism. I therefore felt that this problem was of sufficient magnitude that we have to create some of the sense of crisis that you were talking about. Perhaps suggesting that some much more even burden-sharing across the board is required if we're really serious about this. Now, where might we do that to be specific about it? Well, I think we've come quite a way on automobiles; when you stop and think now we do have mandatory standards that will dramatically increase the efficiency of automobiles in the next several years. But there are other areas in which, by my perhaps imperious and highly discriminatory view, we waste enormous amounts of energy—in our office buildings, for example, where I am still struck, in spite of the price mechanism, with the numbers of buildings that seem to me to be overly-lighted and overly-cooled and overly-heated and so forth. There are extraordinary amounts of energy that I think in wartime, we would all be saying are clearly a waste of the valuable resource. Now conventional political wisdom, and this doesn't necessarily make me wrong, would tell you that I am wrong. But I suspect that sometime in the next year or so, some leader is going to step up and say this problem is serious enough. The alternatives of reducing our dependence are extraordinarily costly in every sense of the word, politically and economically. And, therefore, I think we've reached the point where many of us or all of us are going to have to share in this burden of conservation more directly and more quickly than some of us may have liked and perhaps a little more arbitrarily. But I think, for example, if we took the whole field of temperature standards and lighting standards and cooling standards and heating standards and so forth, that if the American leadership presented this problem, and the American people had the sense that we were all somehow involved in it, and if it didn't involve tremendous intrusions into our homes which I wouldn't think we'd have to do because I imagine most Americans would do it anyway.

I think this is an important missing element in this energy picture right now. The alternatives of increasing energy supply, even if you believe whole heartedly in this ap-

proach as I do, are either very costly or very time consuming or both. No one really has an answer to what you do in the interim. Now we've been very wise I think to start this strategic storage program, but it's very little and very late. I think aside from decontrolling the price mechanism, which as a conventionalist I would hope we would do to put more capital in energy, I think the conservation area is now the area that deserves a great deal more attention than it's gotten. So, I personally, and I do this reluctantly because it does violence to some of my so-called philosophies, think that the area of mandatory standards that apply to all of us is probably the way we're going to have to go if we're politically going to get there in a reasonable hurry.

Question: You mentioned that we're going to have to lower our standard of living. It's utterly ridiculous to say that anybody in this room or anyone in the world is going to lower their standard of living intentionally and as something they want to do. That's ridiculous, we shouldn't talk about that I don't think. Now we may be forced to, but we're not going to do it intentionally, and we're going to strive to increase our standard of living; this makes sense. We talk about the cost of producing new energy, and I grant you it is extremely costly, but cost is relative. How much would a starving man give if he had a pound of gold or a pound of bread? Which would he choose if he had the energy and were freezing to death, how much would he pay for energy? I merely bring these things up because I feel the urgency you were mentioning here, that we must get on with. I have listened here to the nightmare, truly of the past, of the present, and generally it's been a nightmare of the future. Has no one any dreams of a better world or a better future? Are we so devoid of imagination and new ideas that we only deplore where we are and nobody can come up with where we're going to go and have these things? I don't want to leave this conference weeping, which is the way I feel at the moment, and I feel it's my problem because I am so stupid or we're so stupid we people can't do something about it. Doesn't somebody have something encouraging to say?

Peterson: You characterized my position in your way. Let me characterize it in my way. You said I was advocating a lower standard of living. What I am trying to say is because of decades of negligence and ambivalence and shortsightedness we are now confronted with a problem in which all of the alternatives are a bit like Viet Nam in my view, and they're getting worse, not better. And we're not in the fortunate position of being able to make a gradual adjustment as we would hope to make because that possibility ended in October of 1973, in my view. Now, given that we're confronted with these alternatives, we're going to have to make a series of choices, all of which, if I may respectively suggest this, are going to result in some sacrifices in our standard of living of one type or another. Now let me illustrate this. We as citizens can either meet this requirement, and this is probably what you're talking about, by producing more energy and leaving our consumption habits the same, that's one alternative; that alternative, as in Viet Nam, has a couple of problems with it. All of the estimates I have seen suggest that we're going to be lucky in this country to be producing as much energy as we now are 5 years from today from conventional sources, even if we decontrol at a substantial rate, because we have already used up a lot of the lower cost valuable resources in this country. So, then where are we going to get this energy? Well, people say from new energy sources. I've told you what the time-frame and what the cost implications are on those. Our other two possibilities are obvious: coal and uranium. Now I would like to believe that the American political system is going to make the kind of compromises that are involved to move ahead more vigorously than we are on both of those areas. I find little at the present time to suggest that anything short of a crisis is going to bring us to that realization. So, when I talk about conservation I would acknowledge to you that it involves some diminution in our quality of life, but I submit to you, sir, life is a choice of alternatives and sometimes they're all fairly undesirable. I wonder whether the American people, confronted with the current vulnerability that they have and the enormous costs of these new sources of oil, will really, if they're educated to think about unpleasant alternatives, really say to themselves that

the diminution in my quality of life, which is going to take place anyway, is more or less undesirable than something that says, for example, as in automobiles, where we're just going to get used to the idea of getting along with more efficient smaller automobiles. I am not at all sure that saying to the American public, for example, in their office buildings, the temperature standards in the summer are somewhere in the range of 72° or something of that sort, are really a sacrifice that we can't bear compared to the other alternatives. Normally, you see, had we not gotten into this, I'd be the type that would be standing up here saying to you, I believe in freedom and I believe in the market place, and why don't we just let the prices go up and 220 million Americans can make up their own mind about whether they want to freeze in the summer or have incredible light output or both and not eat. And generally speaking I'd say let's use that method of allocation. I think we're coming to the point where the vulnerability of this country exists—not just, Dean Rostow, as you suggested in national security terms, but also on the impact on this economy. What happens to an economy like this, in the face of potential embargoes is so mind-boggling to me at this point, that I would be willing to face up to some of these other alternatives, not because I like to lower my standard of living, but because I like some of the other alternatives less. Now, I've probably done the same thing I've accused you of, I characterized your position, but I am just trying to suggest that my reading of the alternatives. Because we waited so long, and it's a tragedy we waited so long—and you could have another conference on why it is that the American public tends to need some kind of crisis before it does anything—but the facts are we've waited 5 to 10 years too long, our alternatives at the present time, and I hate to sound like a pessimist, are all terrible.

Question: In a speech at the Cosmos Club a few years ago someone remarked that a little austerity is good for science; I think a little austerity may be good for all of us, especially since we've gotten into the obnoxious habit of living off our capital.

Peterson: Among the environmental advantages of consuming less are the things Tex Cook was talking about. We could all probably consume less and be in pretty good shape.

Question: You mentioned the possibility of having the OPEC countries invest more abroad, provided they could benefit from that kind of investment. Let me tell you something first before I put up my question. I was in Saudi Arabia in 1973; by that time the budget that they had prepared and approved in 1972 was something like 12 billion reals, that's around $2.5 billion. Then the prices went up and the next budget they believed they could bring it up to 23 billion reals. By October, when I was there, they told us that the budget execution wouldn't be over 60%. Of course, they told us 60% not to lose face. So, in reality, they probably never came up to 45 or 50%, and later they tried to implement a program for expansion, real big things, but 140 billion in 10 years, and many people in the States were encouraging the Saudis to do this. I didn't know very much about it, I still don't know very much about the project, but I find that in order to do that, in 10 years you know the amount of things you have to know on the financing side and the human resources you've got to have—and alone, the human resources would amount to 700,000 people including skilled labor of some kind—and I knew they couldn't get people like that anywhere, so finally I found what they're talking about, and I am coming down to another program—the investment of $30 billion in 5 years' time, which involves refineries, petro chemicals, and steel factories and what have you, that's one alternative. Now the other alternative is to go out and invest both in the industrialized countries and the underdeveloped/developing countries. If OPEC goes to the developed countries, then a situation like this is going to be present. The more the OPEC countries invest in those countries, then the negotiating power of OPEC will come down, will drop out a little bit. And in the developing country it's something that we are not going to benefit from directly, it's going to be something else. My question is related to that, what do you think about it, how do we handle that kind of a problem?

Peterson: Like yourself, I've had the opportunity myself to go to

Saudi Arabia and visit there with the people. I am sure that their plans are sincere, and they were sincere when I was there in early '74, and they're sincere now and they're even larger. However, I think what they're finding is that any country with limited infrastructure cannot expand as fast as it would like and perhaps deserves to, because there are inherent limitations in its resources. Now in spite of these plans that were enunciated to me in January '74 in Riyadh that they were going to spend $60 billion in the next 5 years, the numbers I have suggest that in '74 Saudi Arabia's so-called investable surplus was $20 billion 700 million in '74 and it was higher than that in '75. In spite of the effect on demand that you're aware of, it was $21½ billion in '75. So I think that however high their priorities, and Lord knows you're absolutely right, their priorities in developing their own economy, and their friends' economies, are much higher than putting money elsewhere, all of the numbers I've seen suggest that Saudi Arabia, Kuwait, and the Emirates at the very least, are going to have very substantial surpluses because of their inability to digest these perfectly extraordinary revenues. So you're then left with the problem of what is the stance you take with regard to what will probably be a couple of hundred billion dollars of capital that is available to be put elsewhere. Are you going to take the stance of creating, what my kids call negative vibes, fears, anxieties of all kinds, or are you going to try to create a world where instead of discouraging this much needed investment, we try to get imaginative and give the oil-producing countries a sense of reasonable return, and what's more important to them, a high degree of security?

I obviously believe that the needs of the world economy are such that we should try to attract that capital instead of frighten it away.

Energy and Economic Growth

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(Dr. McKie wishes to thank Dr. Michael P. Kennedy, Assistant Professor of Economics, and E. Victor Niemeyer of the Department of Economics for their collaboration)

The focus of this discussion of energy and economic growth will be on the advanced industrial economies, exemplified by the United States. We ask whether these developed economies are likely to be able to continue their past rates of growth, in the new era of energy that appears to have begun in the early 1970's. Does the end of cheap energy mean the end of economic growth? Can even the present levels of output and employment be sustained in the United States as energy becomes more scarce and costly?

For well over a hundred years, the accelerating pace of economic growth in the world has been accompanied by a similar acceleration in the use of energy—in the application of energy-based technology to produce more output with less input, and in the substitution of energy for raw human and animal labor power.

In the United States, to consider only the present century, energy consumption—by industry and by final consumers—grew at a rate of 3.2 percent per year up to 1970, while the real Gross National Product grew at a slightly higher rate—3.3 percent.[1] Though energy consumption per capita has not been perfectly correlated with real income per capita, there has been a strong tendency for higher GNP to involve higher use of energy. Similar correlations can be observed elsewhere in the world. These relationships have led many observers to conclude that high real income and self-sustaining growth depend on the availability of cheap and abundant energy, such as the world has had available to it during the last 100 years and more.

The long secular decline in real energy prices was *one* of the reasons for the lavish use of energy that de-

veloped over that period. Energy was cheap; it was becoming cheaper; it was available in seemingly unlimited amounts to the industrialized economies. Not surprisingly, we in the United States used a lot of it. We did not think of energy resources as a factor limiting growth, but as a factor stimulating growth. When we look back on that period—which ended only about six years ago—it is quite apparent that most of our plans, forecasts, technological systems, developmental blueprints, and even our science fiction simply assumed that unlimited quantities of energy would be available at low cost to support any system, any technology, any design, any gadget we chose to put into operation. Even those resource problems that we *had* begun to worry about could be solved with high-energy technology calling upon a highly elastic supply.

The Return of Malthus

The essentially boundless view of economic growth, so characteristic of the middle 20th Century, has not always been the dominant one in economics. A hundred and fifty years ago, the theme was gloomy. Economic systems could grow as capital investment accumulated and as the labor force increased, along with population. Incomes could increase for a time. But there was an inescapable brake on the process: the limited supply of natural resources, especially land. The most famous of these formulations was that of T. R. Malthus. In his world, population would grow, but the food supply would not grow in proportion. Real wages would decline to a minimum subsistence level; profits would fall to zero, and capital investment would eventually cease; life would become more and more miserable until finally population growth would stop; the economic system would have reached a stationary state. That was the inevitable goal of growth. These predictions were what earned economics the name of "the dismal science."

In the view of growth which later became dominant, the constraints imposed by limited endowments of natural resources and energy had dropped out of the picture. What eased these constraints was a factor ignored by Malthus—technological change. The new view was that better techniques of production could outweigh any resource scarcity by making the existing resources more productive and by developing new resources. Productivity could grow faster than population. Population itself would not increase at a rate determined simply by the food supply. Let us call this the steady-growth or balanced-growth school. As it was finally perfected in the 1950's, the steady-growth theory held that growth depended only on labor and investment—the reproducible capital stock—plus the influence of constant accretions to technological knowledge.[2] There were no limits to expansion of the means of production. Per capita income need not fall; it could grow without limit. The economy need not approach stasis. This approach to growth, of course, fitted the observed facts, at least in the Western world, better than the Malthusian predictions did, so it is not surprising that those predictions were pretty much forgotten for a long time except by those who had direct experience with places like Bangladesh.

We all know what has happened since 1970: Dr. Malthus has returned in a new incarnation, armed with the computer and with a vastly more elaborate vision of the nature of the disaster that is bound to overtake us.[3] No longer is it a simple result of the pressure of population and economic growth pressing on all types of limited or exhaustible resources. The stationary state—in a form of "world collapse" even more dire than that foreseen by the early Malthusians—has reappeared in the future, evidently no later than the middle of the 21st Century.

We will not stop to describe the findings of the Club of Rome, nor the many attacks upon them. Nor will we catalogue the developing literature of the no-growth school.[4] It is in large part a reaction by environmentalists to what they perceive as the consequences of economic growth, but it includes more than concern for the physical environment. The sudden swing in philosophical outlook has resulted from the events in the real world that have crowded in upon us so fast since 1970—the food crisis, the environmental crisis, the energy crisis and emerging threats of depletion of other resources on which the world economy now depends, the population crisis, the confrontation between rich and poor nations, between developed economies and those supplying raw materials. It is no wonder that the predictions of an early halt to economic growth have so readily found supporters.

Depletable Resources and Economic Growth

While the prophets of steady-growth usually as-

sumed that energy resources would continue to be cheap and abundant, and hence required no special attention as elements in economic growth, their models were certainly capable of incorporating any changes in natural resource availability. They simply assumed that reproducible capital was a very good substitute for depletable resources, and that where it was not, technological change would overcome the scarcity.[5]

In this standard economic theory, when any depletable resource such as a form of energy begins to show signs of "running out," a market-oriented economy will put out increasingly strong signals that this is happening, in the form of higher prices—provided, of course, that people (and governments) read the future correctly, and provided that no one is manipulating the price to achieve other purposes than economical use of the resource over time. The fact that real prices for energy did *not* rise steadily during the period 1920 to 1970 simply meant that future scarcities were not manifesting themselves in forms that people could easily discern. Technological progress was improving the efficiency of energy production and energy use, and new sources were being developed sufficiently rapidly to offset depletion even while real energy prices were declining. All that had apparently changed by the early seventies.

In trying to discern what will happen in the future, we are very much the victims of present circumstances and present information. We have recently seen how rapidly those can change, so that the same future looks very different from year to year. But let us assume that the pessimistic projections of the seventies are correct, and that supplies of conventional hydrocarbon fuels in the world are being rapidly depleted without much prospect of renewal by discovery of presently unknown reserves—in other words, that the world will actually follow a King Hubbert depletion curve on oil and gas into the next century.[6] Assume also that costs of alternatives (including environmental costs) are a good deal higher than historic prices of oil and gas, and that the technologies of some potential substitutes will be slow to develop.

Put this way, the problem of energy sounds somewhat less threatening than in the scenario of supplies vanishing while an energy-hungry world sinks into famine and breakdown. Yet, depletion of supplies of conventional hydrocarbons while energy costs and prices go on rising does threaten to restrain economic growth. Essentially, the restraint is that more and more of society's resources must go into providing us with the energy we use—resources which could otherwise have provided other valuable goods and services. This problem was not seen to exist until recently. How will the economy of the United States, specifically, react to rising real cost of energy?

Reaction to Higher Energy Prices

In general, economists believe that a complete answer should make use of four properties of our economic system that are often overlooked.

The first is that energy is itself a produced good, not an absolutely fixed stock. Its availability to the economy depends on its price, through the process of investment in the energy industries. The economy tends to react to a developing energy "scarcity" by devoting more of its other resources—capital and labor—to production of energy, if normal economic incentives are allowed to do their usual work. The augmentation of energy output then depends on costs and prices—in economists' jargon, on the elasticity of supply. Of course the picture is complicated when some of the supply is imported and its price is under the control of foreign monopolists.

The second is that energy is an input to the production process, and in most applications non-energy inputs can to some degree be substituted for it. Again, the degree depends on relative price changes. We have used energy-intensive processes in the past partly because energy was so cheap relative to other factors of production, not because we had to produce goods and services in exactly that way.

The third is that goods and services are substitutes for each other, and they don't use the same amount of energy even when they serve much the same purposes. As energy (or a particular kind of energy, such as oil) becomes more expensive, the goods and services embodying it become relatively more costly, and consumers will shift their purchases toward substitutes that embody less. These effects may be as great or greater than the direct reduction of energy consumption caused by higher real prices. Moreover, the substitution effect becomes stronger with the passage of time.

These two substitution effects in a flexible, complex economic structure are bound to be widespread and

pervasive. We can expect, for example, that higher energy prices in the future will have some effects on the way we design and lay out cities—not only through government policy toward zoning and mass transit but through the effect of price signals on consumer behavior. The economic value of living nearer to the central city and of locating workplaces near transportation modes may at last reverse the trend toward suburban sprawl that has been the American way of urban life for thirty years or more.

We are probably on the threshold of a change in building design: the glass Ziggurat that has become so familiar in the Western world since 1945, and which requires huge infusions of energy to be habitable at all even on the balmiest days, may be on the way out. Similarly, domestic home design is beginning to give considerable weight to insulation and heat exchange as substitutes for fuel, reinforcing the direct price effects which may lead consumers to stop overheating their houses in the winter and to get used to being somewhat warmer in the summer.

Food production in the United States has become highly energy-intensive—for running farm machinery, drying crops, packaging, distributing over long distances. One authority has estimated that we consume 10 calories of energy in the United States to produce every calorie of food on the consumer's table.[7] Technological change in the future will probably be directed to energy-saving rather than energy-using techniques, even if they involve using more labor per unit of output. Even the "green revolution" in other parts of the world will no longer expand on the implicit assumption that cheap energy could make fertilizer and other agricultural inputs available without limit at low cost.

Examples both important and trivial can be multiplied endlessly. One would expect the aluminum beer can to become more expensive to use than the tinplated steel one, and that in turn more costly than the returnable bottle; we may be back to a keg on every hearth before we know it. Vacationers confronted with high fuel costs may not only drive smaller and lighter automobiles but leave them in one spot while camping and hiking instead of taking the cross-country tour of seven national monuments in seven days seen from the car window only. Local consumer goods industries may gain at the expense, say, of bread and ice cream trucked in from the distant metropolis. All this may happen in response to energy prices, in addition to any effect that a national conservation campaign may have.

Nor will these changes necessarily be retrogressions to an earlier way of life—even the beer keg may be made of a wood substitute. Scarcities will direct future changes in energy technology in the direction of development of substitute processes and inputs, as has been said. It can produce innovations that economize energy, such as miniaturization. Technology will be chiefly instrumental in developing new forms of energy to take the place of depleting conventional supplies. So this is the fourth property of a complex industrialized economy that we must bear in mind in assessing the influence of energy resource depletion on economic growth: technology is not blind. Technological advance in large part responds to developing needs, and energy prices are now signalling rather pressing needs to "economize" both demand and supply.

ECONOMIC PREDICTIONS: ENERGY PRICES AND GROWTH

The Backstop

Future energy prices, inputs, and outputs depend on an exceedingly complex process of relative growth and substitution. Unfortunately, estimates of some crucial parts of that mechanism are uncertain. The development of alternative energy sources is one part that becomes hard to estimate very far into the future. But most "models" of the process used by economists, engineers, and systems analysts assume that there will be a "backstop"—or two or three—to rescue us from the depletion of prime sources of energy that are now running out, chiefly conventional hydrocarbons.

By "backstop" we mean that more abundant supplies of energy in some form will become available at a later date, and at a higher real cost than the historical costs of the presently favored modes which are more limited in amount.[8] If there is a backstop, then energy conservation at present, and energy prices in the near future, become a matter of making a successful transition to dependence on the backstop source at higher prices. If there is no backstop, then the present energy economy becomes a closed system, and all we can do is make supplies last as long as we can while prices rise exponentially without limit

Historically, of course, we have moved from one type of energy to another along a series of *falling* cost levels. The various types have for the most part continued in use side by side while finding their spheres of relative advantage. But the backstop assumption is that real costs will shift upward while conventional oil and gas are essentially phased out, and that real energy prices must shift upward with them.

Several energy backstops appear likely for the U.S. economy over intervals of the receding future. The first is coal, assuming that the technologies of coal gasification and coal liquefaction will be developed while the switch to a coal-based energy economy is occurring. The second, farther along, is nuclear, assuming again that the technology of the breeder reactor (or, eventually, the fusion reactor) is perfected meanwhile. The third is solar, which may never materialize as an economic source. We don't know what the cost thresholds for coal-based energy and nuclear based on U-238 will be, but it is usually assumed that the supply will be quite elastic once those thresholds are reached. The depletion scale for coal is much longer than for oil and gas, though like petroleum its costs of development may increase over time unless offset by advances in technology. If the breeder reactor comes on as expected, there will no longer appear to be an "exhaustible-resource" limit on the supply of raw energy; the economic problems will be to find the capital for investment in facilities and to protect the environment which has a limited carrying capacity against the effects of nuclear generation.

In trying to "model" the future economic growth of the United States, we can assume a high-cost backstop for nuclear energy after a certain date, with high investment requirements but a very elastic supply of energy if prices rise to the necessary levels. We can also assume a transitional period, during which prices rise steeply above 1970 levels as conventional petroleum is depleted, switching over at some point to a much less steep rise in real costs as coal comes on as the chief base of the energy system, and eventually switching to a highly elastic but high-level cost gradient as nuclear energy takes over. Alternative assumptions about the switchover points, the heights of the thresholds, the elasticities of the supply functions, and resource endowments of fossil fuels available to the U.S. can be plugged into alternate models.

One other supply parameter, somewhat akin to a "backstop" element, has to be included in U.S. energy modeling: the price of foreign oil in the United States. This parameter may be relevant only for the next 20 or 25 years, if world supplies are indeed being depleted rapidly. The most plausible assumption about it is probably that the price of foreign oil will remain high, that it will move upward from a 1970 base, carrying domestic oil prices with it, until the switchover price zone for a coal-based energy economy is reached. But if foreign oil prices for some reason do not behave that way—if world supply should turn out to be much more abundant than we now expect, and if the OPEC monopoly should collapse, leading to much lower world oil prices—then the United States would get more of its energy from that cheaper source. The backstop would be pushed back in time—unless, of course, the U.S. should put an arbitrary floor under domestic energy prices and limit oil imports to forestall those effects. In any event, when modeling U.S. energy and growth we have to make some assumptions about world oil supply, prices to be fixed by OPEC, and U.S. policy toward oil imports.

Some Findings

Several models of the energy future have recently been published. They are based on different sets of expectations and structural assumptions. We need not dwell on the details. Each considers the process of growth in relation to energy supplies, which in turn result from investment in energy production constrained by resource endowments. They incorporate technological change and growth in the labor supply in various ways.

1. *The Nordhaus Model.*[9] This model projects energy consumption and production patterns over the next 40 years and more. Ultimate supplies of exhaustible energy resources are assumed to be fixed. The model takes as given the quantities of usable energy needed, and thus leaves some factor substitution out of the picture. It predicts early exhaustion of proved petroleum reserves and increasing dependence on imported petroleum to about the year 2000, with a transition to a world energy market increasingly dominated by U.S. coal and shale oil after 2020 or so. Transition to nuclear technology—the ultimate backstop—occurs through the 21st Century. Real energy prices (1970 dollars) are

expected to rise at about 1 percent per year for electricity, 2.3 percent for coal, and at about 4.6 percent per year for oil over the next 40 years, by which time oil will be approaching exhaustion. (No solution is provided for the security problem during the remaining decades of the 20th Century, but Nordhaus finds that if oil imports were cut off during that period, energy costs overall to the U.S. economy would increase by about 50 percent.)

This investigation did not try to measure the effect of higher energy prices on growth by incorporating them into an input-output model or a model of growth. But the predicted changes in energy prices (from 2½ times to 5 times 1970 levels by 2010) are evidently not so great as to cause growth to come to a halt; nor is there any probability that exhaustion of energy resources will make it impossible to continue to operate our advanced industrial economy over the long run. Nordhaus does not, of course, provide solutions for short-term disturbances during energy transitions. But the long-run view is optimistic.

2. *The Hudson-Jorgenson Model.* Edward A. Hudson and Dale W. Jorgenson have constructed a more elaborate model of energy growth patterns to 2000, reported in the *Bell Journal* and in the final report of the Ford Foundation Energy Policy Project.[10] It is a model of the entire U.S. economy for the next 50 years or so. The model gives special attention to the role that energy plays in the economy, both as an input to industrial processes and as a final consumption good.

In the Ford Foundation version, the model is run for several different assumptions about energy supply elasticities. In the so-called "Technical Fix" scenario, prices of fuel inputs are expected to increase markedly, with electricity prices more than doubling by 2000 as a result. But (given time to adjust), the ultimate impact of the higher energy costs on the economy is relatively small. By comparison with what would happen if historical growth rates in energy availability were projected into the future, this "Technical Fix" scenario would result in a U.S. real GNP lower by less than 4 percent in the year 2000 that what GNP would have been without significant energy constraints. The *rate* of growth over that period would be slightly lower by about 2/10 of 1 percent per year. The overall price level wouldn't be much affected either. What *would* be much affected is the use of energy. Total energy input would be 38 percent lower in 2000 than it would be if historical growth rates were continued, though GNP would be less than 4 percent lower.[11] There would be no reduction in employment compared to the base case. The main result, then, is that the economy can absorb a major decline in energy use without major dislocation.[12]

Hudson and Jorgenson also analyze the effect of an arbitrary tax of 50 cents per million BTU,[13] which can represent the exactions of a foreign oil monopoly at $3.00 per barrel plus unexpectedly high costs of domestic energy sources by the same amount. They find that the effect of a cost increase of this magnitude from 1973 to 1980 is a reduction of merely one-half of one percent in GNP compared to GNP without the tax; but energy input is reduced by 8 percent by comparison. Prices increase only 1 percent because of the tax.

These are not exact forecasts of actual events, of course. What the models show is that our economy can conserve energy to a considerable degree in response to price increases, by eliminating waste, replacing existing capital with more energy-efficient capital, substituting non-energy inputs for energy, and altering the composition of goods and service output—without anything like a corresponding reduction of output or growth.

3. *The Kennedy-Niemeyer Model.* This model, derived by two economists at The University of Texas, also utilizes an input-output scheme. It analyses growth over the next 15 years in terms of the conventional two factors of the steady-growth approach: capital and labor. Production of energy requires labor and capital. The current output of goods and services can be consumed or invested, in energy or in non-energy industries. The model differs from others by including foreign trade, in which energy (oil) is imported into the U.S. in exchange for exports of other kinds of goods and services. The full model is described in the Appendix to this paper.

Energy supply conditions impact on the economy from two directions: (1) rising costs of domestic energy, meaning that the same capital and labor inputs will produce less of it; (2) changes in import prices, meaning that more goods and services must be exchanged for any given amount of it, leaving less of those things for domestic consumption and investment.

The investigators used a comparative approach.

First, a simulation of the economy was based on historical costs of domestic and imported energy—about $3.50 per barrel of oil equivalent. Under these conditions, the predicted rate of growth of GNP was about 3.5 percent per year, corresponding to historical experience.

Then they assumed other "scenarios." The worst one was that the price of imported oil rose to four times its 1970 level and that the capital and labor resources needed to produce domestic oil and natural gas increased to five times their historical levels. Under these conditions, the model indicated that the economy would experience a 3.0 percent growth rate over a 10-year horizon; that is, that there would be only a one-half of one percent reduction in the growth rate as a result of these major changes in energy conditions.

What is the explanation for this rather startling result? It is that, even at the current high costs for both domestic and foreign sources of energy, the resources needed to meet those costs are still a small fraction of the entire economy. For example, the current U.S. oil import bill, about $25 billion a year, is less than 2 percent of GNP.

We should note that these encouraging results in this particular model do not even include substitution of products by consumers as relative prices change: that would ameliorate the effects of high energy prices still more over the next 10 or 15 years.

Employment

The immediate impact of an energy "crisis" is disruptive. The layoffs in the automobile industry and other activities that were strongly affected by the oil embargo and the sudden jump in prices of 1973–4 should not, however, be mistaken for a long-run effect. Employment, as such, does not depend on cheap energy, if time is allowed for the U.S. economy to make the necessary adjustments to constrained supplies and higher prices. Employment is not linked to energy use by any constant coefficients.

We would expect, in fact, that an economy facing steeply rising real prices for energy might generate an *increase* in employment, or more exactly in the demand for labor. In the past, the U.S. economy has freely substituted energy for labor while reabsorbing the labor in an expanding total production. In the future, expansion is more likely to be in the service industries, and energy-saving techniques may generate expanded demands for labor even though GNP is growing more slowly.[14]

Econometric models of the U.S. again lead to predictions that much higher energy prices over the next 10 to 25 years will have little effect on employment, compared to a continuation of historically low energy prices. As in the case of growth in GNP, any adverse employment effects of high prices would become very small as time goes on. Jorgenson and Hudson, for example, actually predict an *increase* in employment of over one percent by 2000 if energy prices remain at high levels.[15] The Federal Energy Administration is not quite so optimistic; but its projections show virtually the same rates of growth in employment to 1985 with high-priced oil as with low-priced oil.[16]

Lack of an adverse effect on employment in the long run does not mean that restricted use of energy will have no effect on labor *productivity*, or that real wages would not be affected. Perhaps after the preceding spate of optimism we should now add a few cautionary notes.

Some Cautionary Observations

What our economic analysts have said is that energy scarcities are reflected in energy prices, and high energy prices in advanced industrial economic systems need not have very adverse effects on economic growth during the next 15 to 50 years. But that is not to say that growing energy scarcities have no adverse implications at all. They do.

One is that *any* relative increase in scarcity of an important resource is bound to have to some extent a detrimental impact on human welfare. The U.S. economy compensates for a scarcity of energy in part by substituting other things for it in production and consumption, but consumers still would be better off with cheap energy than with expensive energy. The fact that we have a flexible and versatile economy cushions the blow of higher energy prices, but does not eliminate it.

That observation suggests a second qualifier: some economies in the world are *not* flexible and versatile. Leaving aside the countries that are major producers and exporters of energy resources, what happens now to growth and development in the Third World—and the Fourth?

Effects of higher fossil fuel prices in the long run on the developing countries can be considered primarily in terms of their foreign trade. The capacity of those countries to sustain growth depends on their ability to obtain foreign exchange, which they use to purchase from industrial countries the capital goods and technological services that are needed for growth. Higher prices for imported oil use up larger amounts of this precious foreign exchange.[17]

Economic specialists have concluded that some of the developing countries—the rapidly growing, export-oriented ones—can absorb the burden of much higher oil import prices without suffering great damage to their rate of development. Many of them hope to take a leaf from OPEC's laurels and raise the prices of what *they* export. But the low-income, slow-growing countries with large, often destitute populations are in a much poorer case. For these—the Fourth World, perhaps—". . . the most likely outcome is a stagnation of per capita incomes for the rest of the decade"[18] and beyond, unless they receive large additional infusions of aid from the developed and newly rich countries.[19]

A third qualifier: economics is not everything. No word has been said in this paper about political struggles over oil, or the geopolitical consequences of having it or not having it, or the security problem that the United States and its allies may face during the next decade or so. We address the problems of economic growth, while recognizing that political problems may easily overshadow or even nullify them.

Finally, the kind of "long run" we have been talking about is from 15 to 100 years, with a primary focus on the remainder of the 20th Century. That is not the kind of long run that some of the futurists worry about: their gaze is fixed on a time span of as much as several centuries or even more. They are concerned with the *ultimate* depletion of depletable resources, which is inescapable if one remembers the second law of thermo-dynamics. Energy cannot be conserved beyond the rate of entropy. The question is, of course, the effect that the entropy should have upon conservation of energy now. How should we modify our present activity in view of the fact that resources will eventually be used up?

Before we can answer that we must ask how far into the future we can see with any confidence. Lacking any strong moral principle for determining the distribution of income between present and future, we look to the calculus of economic values to tell us how economic resources ought to be used over time. It may appear that we, by using up scarce and exhaustible resources, love our children and grandchildren less than we love ourselves. But the process doesn't necessarily work out that way. Our ancestors may have denied themselves things that we now consider necessities in order to invest enough to create an unseemly affluence for us, and we in turn could live very austerely now in order to make possible a fourth vacation trip to Mars for some unseen great-grandchild. Or, as Kenneth Boulding has put it, what has posterity ever done for us? We want to avoid pauperizing our remote descendants, who will have no recourse but to dig up our graves and desecrate our tombs, but at the same time we want to avoid the error of a Comanche sage who might have counseled his tribe to reduce their consumption of buffalo meat in order to conserve the scarce supplies of arrowhead flint for future generations. And that was only a hundred-odd years ago.

Conclusion

We began with a comparison of the Malthusian outlook on economic growth with the view of the balanced-growth school. It is obvious that the economists reviewed here are still persuaded that the balanced-growth view of the development process is the correct one. What the energy "crisis" has done is to change some of the parameters. The growing scarcities of energy and other depletable resources in the future are reflected in expected higher real prices—some substantially higher. But, in the Western world at least, that is not likely to halt economic growth for as long as we can confidently foresee. In this part of the world, the Malthusians have not been good prophets, and the Neo-Malthusians probably aren't either. The balanced-growth theorists have been good prophets in the past, and the rapidly emerging economic boom in the Western world seems to indicate that they still are.

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1. During the fifty-year period 1920–1970, the energy consumption of the U.S. economy per dollar of GNP in constant prices fell at first and then stabilized. We used 141,000 BTU per dollar of GNP in 1920, but only 95,000 in 1970. Meanwhile, energy use per capita in the U.S. rose from 186 million BTU in 1920 to 335 million in 1970. Joel Darmstadter, "Energy Consumption: Trends and Patterns," in Sam

H. Schurr, Editor, *Energy, Economic Growth, and the Environment* (Baltimore and London: Johns Hopkins University Press for Resources for the Future, Inc., 1972), Table 1, p. 158. The entire world in 1968 consumed 55 million BTU per capita—about one-sixth the U.S. rate of use. The figure for South Asia in 1968 was only 7½ million BTU per capita. *Ibid.* Table 9, p. 179.

2. See, for example, Edwin Burmeister and A. Rodney Dobell, *Mathematical Theories of Economic Growth* (New York: The Macmillan Company, 1970), Chapter 2.

3. D. H. and D. L. Meadows et al., *The Limits to Growth*, A Report for The Club of Rome's Project on the Predicament of Mankind (New York: Signet, 1972).

4. See Herman E. Daly, ed., *Toward a Steady-State Economy* (San Francisco: W. H. Freeman and Company, 1973); Edward F. Renshaw, *The End of Progress* (North Scituate, Mass.: Duxbury Press, 1976).

5. William Nordhaus and James Tobin, "Is Growth Obsolete?" in National Bureau of Economic Research, *Economic Growth*, Fiftieth Anniversary Colloquium V (New York: Columbia University Press, 1972), p. 16.

6. See, for example, M. King Hubbert, *Resources and Man* (Washington: National Academy of Sciences, 1969).

7. John Steinhart of the University of Wisconsin, reported in *The Wall Street Journal*, March 25, 1976, p. 1.

8. Cf. William D. Nordhaus, "The Allocation of Energy Resources," *Brookings Papers on Economic Activity 3*, 1973 (Washington: The Brookings Institution, 1973), p. 532, 547–8.

9. "The Allocation of Energy Resources," *op. cit.*

10. E. A. Hudson and D. W. Jorgenson, "U.S. Energy Policy and Economic Growth, 1975–2000," *The Bell Journal of Economics and Management Sciences*, Autumn 1974, pp. 461–514; *A Time to Choose*, Final Report of the Energy Policy Project of the Ford Foundation (Cambridge, Mass.: Ballinger Publishing Co., 1974), Appendix F: "Economic Analysis of Alternative Energy Growth Patterns, 1975–2000," pp. 493–511.

11. Energy input would increase from 78 quadrillion BTUs in 1975 to 115 quadrillion, rather than to 185 quadrillion by 2000, as it would if past conditions continued into the future.

12. *A Time to Choose*, p. 501.

13. *Bell Journal*, Autumn 1974, pp. 501 ff.

14. See Herman A. Daly, "Electric Power, Employment, and Economic Growth" in H. A. Daly, ed. *op. cit.*, especially pp. 260–263.

15. In the "technical fix" scenario. *A Time to Choose*, p. 494.

16. In both cases, employment growth 1973–85 is projected at 1.5 percent per year. Federal Energy Administration, *Project Independence Report*, November 1974 (Washington: U.S. Government Printing Office, 1974), Table VI-2, p. 320.

17. Wouter Tims, "The Developing Countries," in Edward R. Fried and Charles L. Schultze, Editors, *Higher Oil Prices and the World Economy: The Adjustment Problem* (Washington: The Brookings Institution, 1975), pp. 169–195.

18. *Ibid.*, p. 195.

19. See the Editors' "Overview" in Fried and Schultze, *op. cit.*, p. 38.

Appendix: A Model of Energy and Economic Growth

Michael Kennedy
E. Victor Niemeyer

This paper describes the structure and behavior of a two-sector economic growth model which is designed to simulate the effects of energy scarcity on economic growth. It will first describe in detail the structure of the model, and then present results of runs of the model done under varying assumptions.

Model Structure

1. Production

There are two goods produced and consumed in the economy, Materials (M) and Energy (E). They are each produced by two factors of production, capital (K) and labor (L). Q_M, the gross output of good M, is related to the amount of capital and labor applied to its production (K_M and L_M) through the production function

$$Q_M = f_M(K_M, L_M). \tag{1}$$

A similar relation holds for good E;

$$Q_E = f_E(K_E, L_E). \tag{2}$$

In addition to capital and labor inputs, intermediate flows of goods are required for production. That is, inputs of M and E goods are needed as intermediate inputs in the production of gross output of M and E. These relations are summarized in the 2×2 input-output matrix A, whose elements are denoted $a_{XY}(X = M, E;\ Y = M, E)$. For example, a_{ME} is the amount of intermediate input of good M needed for production of one unit of good E.

Net outputs of the two goods, Y_M and Y_E, which are the amounts available for consumption, investment, or export, are related to gross outputs through the matrix equation

$$\begin{pmatrix} Y_M \\ Y_E \end{pmatrix} = \begin{pmatrix} Q_M \\ Q_E \end{pmatrix} - A \begin{pmatrix} Q_M \\ Q_E \end{pmatrix}. \tag{3}$$

If P_M is the price of materials and P_E is the price of energy, GNP in the given year is $P_M Y_M + P_E Y_E$, or the value of final goods production.

In any given year, we assume that the capital available for use in each of the two sectors is fixed.

$$K_M = \overline{K_M} \tag{4}$$

$$K_E = \overline{K_E} \tag{5}$$

This amounts to an assumption that capital is not malleable, i.e., that once it is installed for use in one sector it cannot be transferred to any other sector. Also, since capital cannot be augmented by new investment in the given year, it implies a one-year gestation lag for new capital formation. We assume that labor is fixed in the aggregate, but can be allocated among the two sectors in any proportions.

$$L_M + L_E = \overline{L}. \tag{6}$$

2. Consumption and Saving

We assume that 15% of GNP is saved and used to make additions to the capital stock. The capital stock is composed only of good M. The real volume of M goods used for additions to the capital stock in any year can then be expressed as

$$I = \frac{.15 \cdot (P_M Y_M + P_E Y_E)}{P_M} \tag{7}$$

The remaining 85% of GNP is used for consumption expenditure. Consumers are assumed to maximize a Leontief type utility function of the form

$$U = \min\left(\frac{C_M}{\overline{C_M}}, \frac{C_E}{\overline{C_E}}\right) \tag{8}$$

given total consumption expenditure and the prices of the goods. In this, C_M and C_E are the amounts of consumption of each of the two goods, and $\overline{C_M}$ and $\overline{C_E}$ are amounts of the goods that compose the unit bundle. The consumer demand curves derived from these assumptions are

$$C_M = \frac{.85 \cdot (P_M Y_M + P_E Y_E)}{P_M \overline{C_M} + P_E \overline{C_E}} \cdot \overline{C_M} \tag{9}$$

$$C_E = \frac{.85 \cdot (P_M Y_M + P_E Y_E)}{P_M \overline{C_M} + P_E \overline{C_E}} \cdot \overline{C_E} \qquad (10)$$

(In the absence of international trade, quantity balance equations for this economy would be

$$Y_M = C_M + I \qquad (11)$$

$$Y_E = C_E.) \qquad (12)$$

3. International Trade

The economy is assumed to be a price taker in international trade. That is, there is a fixed relative price of energy to materials, q, which is set by forces independent of the economy in question. (These forces may, of course, be a foreign price-setting cartel.) The economy is free to import or export as much of either good as is desired, provided it stays within its international budget constraint, that is, provided the balance of trade is zero. Note that this framework implies that intercountry movements neither of factors of production nor of financial flows are allowed. In the absence of domestic trade impediments, the foreign conditions determine relative domestic prices through the relation

$$\frac{P_E}{P_M} = q. \qquad (13)$$

The model is currently set up so that the country is normally an importer of energy and an exporter of materials. Letting X_M be exports of matters and M_E imports of energy, we have these new material balance equations.

$$Y_M = C_M + I + X_M \qquad (14)$$

$$M_E + Y_E = C_E. \qquad (15)$$

These simply say that availability of each of the two goods must be equal to absorption of them. The international budget constraint, or the trade balance condition, is

$$X_M = q\, M_E. \qquad (16)$$

4. Dynamics: Capital Accumulation

The theory of the economy given so far is sufficient to determine its static behavior. For given sector-specific stocks of capital, overall labor force, production functions, final product demand functions and foreign conditions, the equilibrium levels of output and trade in any one year can be determined.

The dynamic behavior of the economy is determined through the relation between investment in one year and capital stock accumulation in the following year. Let I_M be the amount of investment goods used for accumulation of the capital stock in materials production, and I_E be the amount used for accumulation in energy production.

$$I = I_M + I_E. \qquad (17)$$

We assume that capital in each sector depreciates d% per year. The accumulation equations are then

$$K_M^{+1} = (1-d)K_M + I_M \qquad (18)$$

$$K_E^{+1} = (1-d)K_E + I_E \qquad (19)$$

where the (+1) refers to the succeeding year.

The crucial issue in dynamic behavior, of course, is how the allocation of investment goods between the two sectors is made. Let π_M be the rate of profit earned on capital in the manufacturing sector, and π_E be the rate earned in the energy sector.

$$\pi_M = \frac{P_M Q_M - P_M a_{MM} Q_M - P_E a_{EM} Q_M - wL_M}{K_M} \qquad (20)$$

$$\pi_E = \frac{P_E Q_E - P_M a_{ME} Q_E - P_E a_{EE} Q_E - wL_E}{K_E} \qquad (21)$$

(w is the wage rate.) We assume that the relative flows of investment into each of the sectors depend on these profit *rates*.

$$\begin{pmatrix} I_M/I \\ I_E/I \end{pmatrix} = h(\pi_M, \pi_E) \qquad (22)$$

Note that this implies perfectly myopic expectations on the part of investors; neither past nor anticipated future rates of profit influence the investment decision. This is a shortcoming we hope to deal with in future research; one possibility is at least the inclusion of a distributed lag on past profit rates, another a projection of future relative prices based on past trends.

5. Resource Depletion

An important consideration in modelling the impact of energy on economic growth is the possibility of rising costs as a function of cumulative production. We have included this possibility by giving the energy production function a slightly different form.

$$Q_E = \gamma f_E(K_E, L_E) \tag{23}$$

γ is a factor neutral efficiency parameter which is assumed to deteriorate as a function of cumulative energy production, down to a "backstop" minimum level.

$$\gamma_t^{-1} = \begin{cases} 1+\beta \sum_{\tau=1}^{t-1} Q_E^{\tau} & \text{if } 1+\beta\Sigma Q_E \leq B \\ B & \text{otherwise} \end{cases} \tag{24}$$

(γ^{-1} was chosen as the variable of interest since it corresponds to an increasing factor neutral penalty in the cost function associated with the energy production function.) One possibility in this formulation, of course, is no influence of previous production on production possibilities, or constant returns in energy production. This corresponds to $B=1$.

A serious problem with this approach is that it still assumes that energy producers maximize profits subject to the given production function in each year. Thus, it ignores the Hotelling phenomenon of a user cost arising in energy production due to higher future extraction costs. Since there are neither intertemporal markets nor price expectations currently in our model, this is inevitable. It is an extreme (and dubious) result of the perfectly myopic expectations assumption; i.e., energy producers do not anticipate future costs, but are simply faced with them each successive year until the backstop is reached. Again, this is a situation we hope to improve upon in future work.

Numerical Assumptions

We have not yet attempted to estimate the parameters of this model with historical data. Instead, we have made assumptions about the values of the parameters, which are detailed below. Thus, the simulations we have done have the purpose of supplying information about changes in the outcome of such a model in response to changes in exogenous conditions. That is, we wish to see how the system behaves when certain key determinants of its evolution are varied. From this, we hope to get some insight into how a real economy will be affected by changes in conditions of energy supply.

Two factors indicate that this approach has value. First, the behavior of a system such as this is so complex that analytical expressions for derivatives of endogenous variables with respect to exogenous variables are impossible to derive, so that simulation is the only effective method of learning about it at all. Second, the numbers we have chosen are meant to roughly represent the U.S. economy. Thus we feel that the results have some real world relevance, although the reader must judge this for himself.

The base year of the model represents the U.S. in 1972. The economy is in equilibrium in this year when all prices are unity. The quantities (in billions of 1972 dollars) corresponding to this equilibrium are

$Q_M=1915$	$Y_M=1128$	$K_M=1161$	$C_M=941$
$Q_E=91$	$Y_E=22$	$K_E=71$	$C_E=37$
$\pi_E=\pi_M=.35$	$L=723$		
$M_E=X_M=15$			

The production functions are CES with an elasticity of substitution of .25. The A matrix is

$$\begin{bmatrix} .40 & .02 \\ .23 & .34 \end{bmatrix}$$

The labor force grows 1.5% per year, and Harrod neutral technical change occurs in each sector at 2.5% per year. As mentioned above, in the base year $q=1$.

Capital depreciates at 10% per year. The allocation of investment among sectors follows the rule

$$\frac{I_M}{I_E} = \frac{\pi_M K_M}{\pi_E K_E}, \tag{25}$$

or that relative allocation of investment goods equals relative gross profits. Note that this does *not* imply that each sectors' profits are reinvested, since there is the further constraint that nominal investment must equal 15% of nominal GNP. We also constrain growth of the energy capital stock to be less than or equal to 7% per year.

Simulations are done over different values of the backstop energy production efficiency level, B, so that this important parameter's effect on growth can be investigated. In all cases, the backstop is reached when cumulative gross production reaches a level of ten times the base year's production.

Due to the Leontief utility function assumption, an unambiguous measure of consumption welfare is available. The simulations described below have as their main output the growth of this measure of welfare over the intermediate run.

Results of Illustrative Simulations

The model has been run over a 10-year horizon under varying values of q and B. Results are shown in Table 1.

Since prices are set to unity in the base year, q=1 means that foreign producers are willing to supply energy at relative prices prevailing in 1972, and B=1 means that domestic energy can be produced at resource costs prevailing then. An increase in either of these variables retards consumption growth in the following ways. If q is increased, a first result is that more material goods must be sent abroad in return for energy imports. In response to the change in relative prices, more capital and labor will be devoted to energy production, leaving less available for accumulation in the materials sector and resulting in lower future materials output. If B is increased, resources must similarly be transferred to the energy sector to maintain production, again leaving fewer available for materials production. Both phenomena lower society's consumption possibility frontier and lead to decreased welfare.

If q=1 and B=1, the assumption of Harrod neutral technical progress means a balanced growth path of 4% per year is available. This result can be seen in Table 1.

TABLE 1
Average Annual Growth Rates of Real Consumption

After 5 Years

	Resource Backstop (B)		
Energy Price (q)	1	3	5
1	4.0	3.7	3.6
2.5	3.8	2.2	1.7
4	3.7	1.0	0.1

After 10 Years

	Resource Backstop (B)		
Energy Price (q)	1	3	5
1	4.0	3.9	3.9
2.5	4.0	2.9	2.7
4	4.0	2.2	1.8

If either q=1 or B=1, changes in the other factor have minimal impact on the growth of consumption. This is easily seen in the case of q=1; if the domestic economy suffers a deterioration in its ability to produce energy but can continue to exchange materials for energy on the foreign market on favorable terms, production merely becomes more material intensive in accord with the principle of comparative advantage. In the long run, energy production would shut down and the economy would return to a 4% balanced growth path producing only materials. If B=1 but foreign prices rise, a reverse phenomenon occurs, and the domestic economy produces its own energy at a lower opportunity cost in terms of materials than that available abroad. In this case, the economy eventually becomes

import-independent and converges to an autarkic balanced growth path. Table 1 shows that this occurs very rapidly with the model under consideration here; this is because, at prices prevailing in 1972, the energy sector was so small in relation to the rest of the economy that only a modest reallocation of capital, available through new investment, is needed to make up for existing imported quantities.

The current existing feeling of vulnerability to foreign energy sources, of course, stems from a belief that domestic energy production cannot be substantially increased at historical costs. The combined effects of higher foreign prices and domestic cost increases are shown in the rest of Table 1. The worst case, q=4 and B=5, leads to no growth in real consumption in the first five years, and 1.8% growth over a 10-year period. Given the 1.5% labor force growth, this means stagnation of real per capita consumption over the 10-year period.

Three observations concerning these results are in order. First, the impacts on intermediate run growth seem to be quite modest given the large cost increases postulated. This is again basically due to the small role that energy plays in the economy as a whole, even at current higher prices. Second, once the backstop has been reached and foreign prices stabilize at a new level, the economy will gradually regain a 4% growth path. It will proceed, of course, from a lower level. Finally, the short run decrements in consumption may well be overstated in the case of higher foreign prices, since foreign producers, due to absorptive capacity constraints, may be willing to accept financial claims in return for energy imports.

Another interesting aspect of these runs is the implied demand curve for imported energy as a function of the relative price of energy. This curve is of course the difference between domestic use of energy and gross domestic production, and will thus be more elastic than either of those two functions. Table 2 shows the 5-year and 10-year import demand functions for each of the backstop assumptions.

If B=1, the curve is extremely elastic, as the economy becomes self-sufficient in response to higher prices over a 10-year period. This phenomenon was discussed above. At other backstop levels familiar demand curves arise. In the tenth year, the arc elasticity of demand between q=1 and q=4 for B=3 is −.44, and

TABLE 2

Imports of Energy
(Billions of 1972 $)

In Fifth Year

	Resource Backstop (B)		
Energy Price (q)	1	3	5
1	17.5	54.0	65.3
2.5	3.0	37.1	48.2
4	1.2	34.0	44.6

In Tenth Year

	Resource Backstop (B)		
Energy Price (q)	1	3	5
1	21.4	89.3	97.5
2.5	0.0	56.4	68.9
4	0.0	52.2	63.0

TABLE 3

Gross Production of Energy in Year 10
(Billions of 1972 $)

	Resource Backstop (B)		
Energy Price (q)	1	3	5
1	130	28	16
2.5	163	68	48
4	164	70	51

for B=5 is −.36. Thus, import demand becomes less elastic as resource depletion becomes more severe. (The elasticity at B=1 is $-\infty$, of course.) It should be noted that most of the reduction in import demand occurs between q=1 and 1=2.5. This is because at q=2.5 energy production is profitable enough that its capital stock is already growing at the maximal allowed rate of 7% per year. The increase in price to q=4 can only spur energy production by leading to more labor-intensive use of a given capital stock, which offers little opportunity for increased output due to the low elasticity of substitution. Table 3 shows the gross production of energy in the tenth year as a function of q and B, and illustrates these points.

Finale

The model presented here is a stark oversimplification of reality. Aside from the shortcomings already mentioned, one must include the lack of a monetary structure and the assumption of perfect price flexibility, perfect labor mobility between sectors, the absence of government taxes and expenditures (especially important in profit calculations), the lack of domestic policy variables such as price control and import regulations (which heavily influence current energy-related phenomena), and the absence of any flexibility on the part of producers and consumers in substituting other goods for energy.

We nonetheless feel that this is a useful step forward in providing the beginnings of a general equilibrium framework for analyzing the impact of the energy sector on the economy as a whole. We are currently engaged both in improving the theoretical basis of this small model and in developing a larger, empirically based model from which numerically plausible results can be derived.

Discussion

Question: I have been very much interested in your model study for ways to answer some of the questions that have come from the floor this morning. Many are perturbed about the present situation. In looking at the world pricing situation, there's a matter of the existing price of Middle East oil, 13 or 14 dollars a barrel. The old system has given way to the present system with the Middle East more or less arbitrarily setting the price. I'm confused, and maybe many of us are confused with respect to future price predictions. The situation in Iran is some indication that the present oil there will be stabilized providing the cost of imports will match it. But that is probably not the whole picture, and my question is, what method do you think will be used to establish the future price of oil?

McKie: So far as the world oil pricing situation is concerned, I think the method will be pretty much under the control of OPEC, and I really have no helpful suggestions. They seem to be doing very well by themselves. If our picture of that situation that emerged in this conference is correct, if I can base my answer upon the observations of Sheikh Abdullah Tariki yesterday, several of the major producing countries are prepared to act as a balance wheel to regulate supply to world demand at present or even higher prices, and over the long run this may make a good deal of sense. Of course our estimates of the future supply of oil in the world are surrounded with uncertainty and we could easily be far far wrong. We've been wrong before. But if present predictions are correct, the present pricing strategy of OPEC makes a great deal of sense over the long run, and I think that the logic of events combined with their power and the new-found machinery for working it this way will add up to a continuation of the present situation. How we react to that in the United States—to continued high and even rising import prices with respect to our domestic economy—is, of course, a matter for domestic politics. In my opinion the two-price system makes no sense at all. The question really reduces to what do we do if the OPEC price should collapse. If a short-term surplus should appear on world markets and undermine the world price to the point where we are back to $3 or $4 a barrel on world markets again, that will present a very difficult problem to domestic policy. It will raise the floor price question again with a vengeance. We have evaded it up to now, but I suspect there are a good many people in Washington concerned with the energy problem who are secretly hoping that OPEC will continue to live and prosper.

Question: Would you comment, please, on the history of inflation from World War II to present, how the 1973 OPEC actions affected inflation in this present period, and where you think inflation will go?

McKie: Well, the oil price on world markets is probably the most important number in the world but it isn't the only number. I'm not an expert on inflation, and I have not studied the question of world-wide inflation sufficiently to be able to say just what proportional part the price played in it. Of course, it is a strategic variable in that it is an important number, and the change in it was so abrupt and had such a powerful short-term impact upon full trade and upon welfare and upon a number of very important variables that policy in the various countries of the world tended to react to that. All too often the reaction of policy to an event of that kind is to inflate the money supply in an effort to ameliorate the effects. Frequently that is the most popular thing to do, so if there is a fall in real wages some place owing to the impact of constrained energy supplies and higher real prices of energy, you can have this illusory compensatory effect of changing the money wage in an effort to make up for it. We have certainly observed that. But beyond that I don't think I'd care to go. The lines of causation through the operation of the world monetary system are another big problem and I'm not an expert on the question.

Question: I'd like to make a technological comment rather than ask a question. You remarked that energy has figured as a parameter in the design of technological systems in the form of being essentially free or very low priced. Let me supplement that with the following remark that practically all of the components of our technological society have been designed upon the assumption that energy is very low priced and that disposal of the inevitable waste products is essentially for free. Both of those assumptions now have to be examined, and this

means, it seems to me, that we are really on the threshold of a second technological revolution in the course of which we will have to reexamine the basic design parameters of every major component of our technological society. Now whether the gains to be realized from this have been fed into the Ford assessment or not, I don't know. But if they haven't, then even that optimistic forecast might prove to be pessimistic.

McKie: Certainly the changes in engineering specifications that you speak of owing to what you might call a reorientation of technology—a discontinuous abrupt change in the direction of the technological rules—are not incorporated into the Ford model or anybody else's, because those are econometric models, and of course they fit their functions to the existing statistics which are historical. So they only predict the effect of prices in terms of the existing technology. You're quite right. I think that that technological epiphany has become quite obvious, and the engineering schools, of course, are already working on it. If our present situation which began in 1970 continues, it will certainly revolutionize engineering and not only the processes of production but the way we live because that has an engineering dimension too.

Question: Mr. McKie, I want to thank you much. I would like to ask you what is the reason or reasons that only 4% surplus from the oil money is invested on a long term in the United States, and what should be done to attract this huge sum of money for the benefit of mankind and energy sources?

McKie: Are you speaking of 4% of the earnings of other countries?

Question: The surplus, yes, from the oil money in Saudi Arabia, Kuwait, Iran, and the other OPEC countries.

McKie: Well, I confidently expect that percentage to rise. I wasn't aware that it was that low, as a matter of fact. But we are only two years into the new era and it takes time to get used to it. It's partly a question of working out new institutional arrangements in international investment, and it's partly a question of what guarantees can be given and the development of mutual trust and the exchange of technological information. And a lot of other things. But, it takes time to do that and I believe that it should take time to do it. We have a tendency to go off half cocked on these things and contrive crash programs which have to be abandoned with a crash in 18 months. Let's work up to that gradually. But it will happen.

Conference Closing Session

The World Survival Bargain

Dr. Richard N. Gardner
Professor of Law and International Organization at Columbia University, New York City

Discussion

Energy and Man

Mr. William S. White
Author, journalist, Pulitzer Prize recipient

Discussion

Closing Remarks

The Honorable Edward A. Clark
Dr. Lorene L. Rogers

The World Survival Bargain

Dr. Richard N. Gardner
Professor of Law and International Organization at Columbia University, New York City

Mr. Chairman, Mr. White, ladies and gentlemen. When Dean McKie met me at the airport last night, I asked him, "What exactly do you want me to talk about?"

And he said, "Well, you're the next to last speaker. Why don't you pull it all together? Tell us about the next 50 years. Show us all the interrelationships among energy, environment, population, food, and development."

And I asked him, "Well, how long do I have to do this?"

And he said, "Forty minutes?"

And then I thought to myself, "How did I get into this mess?" And I recall the reason. I am a charter member of a very exclusive club known as the International Division of International Organization and Transnational Specialists, otherwise known as IDIOTS. I was so shaken by Dean McKie's mandate that I went to the reception, had three very stiff drinks and then went to bed.

And then a very strange thing happened to me, ladies and gentlemen, which I must now recount to you. I went to sleep last night in my hotel. I was awakened at about 2 a.m. in the morning to hear some very curious noises. There was a clanking and chains and some moaning and groaning. Then my room lit up, and I saw a thin, emaciated-looking man dressed in rags standing in front of my bed. "Who are you?" I asked.

"I am the ghost of the world future," he answered.

"Go away," I said, "you look like some silly character out of Charles Dickens."

"Don't make fun of me," said the ghost sternly, "or you'll regret it for the rest of your life." And with that, ladies and gentlemen, he grabbed me by the bony hand, and by some magic we were soon flying high over the roofs of this city.

"Oh, no," I thought to myself, "I should never have had that extra drink last night at the Ransom Center reception."

Well, the Spirit took me on a long voyage through time and space until we came to a desolate wasteland where there were no trees or flowers, and human beings were all huddled in underground dwellings. We came somehow into one of these dwellings where two old people—a man and a woman—were sitting at a table. "Who are these people?" I asked.

"They are your children," said the Spirit.

"But they're old and bent and their hair is gray," I said.

"Of course, this is the year 2030," said the Spirit.

"But why are they living underground in a joyless house with no windows?"

"It's too dangerous above ground," the Spirit explained, "too much radioactivity for one thing. You see, around 1990 a missile with 100 independently targeted nuclear warheads was launched by accident from a submarine. No one is sure whether it was American, Russian, Chinese, or just one of the submarines operated by the Mafia. And since then atomic bombs have been exploded almost every year by nations or terrorist organizations.

"But why is this house so bare?" I asked. "It looks like a prison cell."

"The world economy collapsed around 1984," answered the Spirit. "Surely you're not surprised. Even at the time of your Austin energy conference, spending on arms had passed 250 billion dollars a year. By 1984, despite the SALT Agreement about which you were all so proud, arms spending had reached an annual rate of more than a trillion dollars. The economies of the poor nations collapsed first, particularly those who were exploding nuclear devices or buying jet aircraft when they couldn't feed their own people. And then even the advanced industrial nations began to disintegrate under the arms burden. But," the Spirit went on, "probably the richest countries could have survived if the Arabs hadn't decided to withdraw 300 billion of their petrodollars from the Eurodollar market one weekend in the summer of 1984. By the way," the Spirit added with a sardonic smile, "your children are living in the Eighth United Nations Development Decade."

"But why are my children all alone?" I asked. "Didn't they marry? Don't they have children?"

"I'm sorry to tell you that your daughter's husband and your son's wife died in a terrorist raid on the city many years ago. There is no effective government anymore, you know."

"But surely their children had children," I protested. "Surely there must be some grandchildren to comfort them in their old age."

"There are no grandchildren," said the Spirit. "When world population passed 12 billion in the year 2020, after the failure of the Eleventh World Population Conference, all but a relatively few privileged couples were sterilized."

"Why are they nibbling those strange pills at the table?" I asked.

"That's their dinner," said the Spirit. "You can't expect them to eat bread now that it's selling at three hundred dollars a loaf. And there's no meat left, of course. And don't even ask about fish. After ten years of futile negotiations, the Law of the Sea Conference broke up in futility. By that time overfishing had depleted most of the stocks of edible fish, and the remainder were poisoned by sources of pollution which the UN Environment Program was never permitted by its members to control."

At that point an entire wall of the room suddenly lit up, and the image of a man appeared about 10 feet high in living color. "What's that?" I asked.

"It's time for the evening television news," said the Spirit. "You see the one thing that people still have is television. It's bigger and better than ever, and it takes their minds off their problems."

The face on the wall in living color began to speak. "Good evening. This is Walter Cronkite the Third. I have good news for you tonight. The United Nations has just decided to create a Commission on the Future that can help us all plan a better world."

The old man turned off the television set in disgust. The old lady said, "Didn't our father once go to United Nations meetings?"

The old man answered, "Yes. He was a fraud like everyone else. He did a lot of talking, but he never did anything."

"Spirit," I said, "I can stand no more. You must tell

me something. Is this a vision of what must be? Or is it only a vision of what might be if mankind doesn't change its ways?"

"Come, now," said the Spirit, "you're supposed to be a futurist. This is only a scenario—a scenario of what will happen if you go on as you are. There are other and more hopeful scenarios."

"Then what must we do?" I asked.

"You and your friends at that International Energy Conference in Austin," said the Spirit, "know in your hearts what you must do, though you probably will be too diplomatic to say it. You human beings must stop worshiping at the idol of nationalism and start accepting the moral, political, and economic implications of interdependence. You must recognize that the greatest difference in the world today is not between communists and non-communists, between rich and poor, between blacks and white, or between young and old, but between those who can see only the interests of a limited group, and those who can see the interests of mankind as a whole. You must," the Spirit continued, "replace balance-of-power politics with world order politics. You must convert arms control agreements into genuine disarmament, give international institutions real power for peace-keeping and peace-making, double the transfer of resources in the Second Development Decade, insist that governments rule on behalf of all the people and not just a privileged few, and put into effect a world survival pact with a world food policy, a world energy policy, a world environment policy, and a world population policy to bring man and nature into balance." And the Spirit concluded, "You must also tell your friends in Austin what you've seen tonight. Perhaps if they tell the men who run the affairs of the world about the future I've shown you, they can be persuaded to change their ways before it's too late. But there isn't much time."

And with that, Mr. Chairman, this strange dream ended, and I found myself sitting in my room all alone.

I have obeyed the Spirit's orders to tell you what happened, but as I said at the outset, it probably is just the result of overindulgence of last night's reception, and I'm not really responsible for what I say.

Now, how do we avoid this nightmare future shown me by my strange night visitor? What would be the elements of a world survival pact? I don't claim to know the answers. I'm sure I don't know the answers, but I will try in a few minutes to suggest some directions in which we might move if we are seriously concerned with the adverse trends that now threaten human civilization.

I speak of a world survival pact or a world survival bargain. The terms are chosen to suggest something that's quite fundamental: that no world policy will be imposed by a world government. We are going to live for the foreseeable future in a world of nation states. And world policies will have to be reached as a result of negotiation. We are engaged in global bargaining on an unprecedented scale. And as in any bargain the agreement will only be reached on the basis of consent, and it will only be entered into if it serves the interests of all the parties. Now this may seem self-evident, but if you attended as many debates at the UN as I've been obliged to, I think you would be depressed by the tendency of some countries to think that their views can be imposed on other countries by majority votes. And you would also be depressed as I have been in the last few years by some of the more extreme rhetoric in the UN which suggests that the rich countries in the world are going to do more for the poor countries on the basis of guilt about past colonialism so-called, or neo-colonialism.

When I talk about global bargaining, I'm trying to emphasize the point that that approach is not going to work. We're going to make global bargains based on appeals to self-interest, and in a government constituted such as the United States, a government with the consent of the governed, it's only if the governed and their elected representatives in the Congress see something in it for us that we are going to enter the agreement. And the same applies to other democratic countries. So we have to have a new global bargain based on mutual interest.

Now I'm going to suggest eight elements of such a survival pact or global bargain. And they will all illustrate in one measure or another the paradox that the world of nation states will have to be brought voluntarily to accept limitations on their national sovereignty in order to assure them mutual survival. Qualifications in the sovereignty of each will be necessary to perfect, as it were, the sovereignty of all, for the paradox of contemporary international relations is that sovereignty can only be preserved by its creative and collective use—the voluntary acceptance with other nations of mutual restraints and reciprocal concessions that protect and even enlarge the capacity of each nation to

carry its unique purposes into action. Sovereignty is often forgotten as a positive as well as a negative meaning. It is the right to say "yes" as well as the right to say "no." In this sense the new survival bargain can be seen as the application at the planetary level of the old social contract of Jean-Jacques Rousseau by which individuals escape from the state of nature and gain the advantages of association with others in a civilized community under law. Now since time is short, I will be able to do no more than, as it were, give you the chapter headings and the summary of the eight chapters. And if we have time in the discussion period perhaps we can probe a little further.

The first element of what I see as the survival bargain is perhaps the most far-reaching, and some of you may resist it. But I think it's absolutely fundamental. Pete Peterson spoke this morning of this new international economic order that's being talked about in the United Nations. But I submit to you that item number one in the global economic bargain is not the new international economic order, but the new internal economic order in both rich and poor countries. This means that some of the poorer countries which have been receiving vast quantities of international assistance for 20 years and more will have to do more to limit population growth and increase productivity and distribute more adequately within their societies the Gross National Product for the bottom 40 percent of the population. And it means that some of the wealthier countries, including the United States, will have to take effective measures to reduce waste and overconsumption, particularly in energy and food, along the lines that some of the speakers this morning have discussed. These have traditionally been regarded as internal matters. They can no longer. They are integrally related to the survival of the human race. And these so-called internal matters must now be subject to international discussion, and I would submit eventually international agreement and international monitoring and surveillance, not yet by a world government with compulsive power, but at least with a proper procedure for cross-examination and international discussion of internal matters of vital international concern.

Now this means specifically that international assistance to countries like India which frankly has given foreign aid a bad name, because the world community has poured billions of dollars into India with very precious little result. In fact the GNP per capita in India is probably today hardly more than what it was in 1960. But the international community will have to target international assistance to such countries on two things: increasing productivity, particularly in the agricultural area, and secondly, meeting of minimum human needs—and I would identify four minimum human needs which ought to be integral to the human personality everywhere—nutrition; health, including family planning; education; and jobs, because the people in this country, and I think this is true of most countries of the world, are tired. To quote a current candidate for the Presidency, and I guess it's an election year, and I shouldn't identify him, but I'll give you a hint, he speaks with a southern accent. To quote this candidate for the Presidency, "It is time to stop taxing the poor people in the rich countries for the benefit of the rich people in the poor countries."

You know the statistics on income distribution are fascinating. These have been now fully published by the Overseas Development Council. Countries like India and Tanzania that call themselves socialists have a much less equal distribution of income than the United States and the United Kingdom. To be specific, in the U.S. and the U.K. the top 20 percent of the population earns 40 percent of the GNP, the bottom 40 percent of the population, 20 percent of the GNP. In India and Tanzania, the top 20 percent earns between 53 and 58 percent of the GNP, and the bottom 40 percent about 13 to 16 percent of the GNP. And the days in which income distribution can be regarded as a matter of internal affairs for a country that's draining valuable resources, including food, out of the international system—those days are gone.

All right, so point number one is the new internal economic order and adequate international measures to prod countries, both rich and poor, to behave in ways that are compatible with human survival.

The second point, and it's tied to the first one, is that in return for this there has got to be an increased international investment. I use the word investment rather than foreign aid because the kind of investment I'm talking about is in helping developing countries do things that are in our interest as well as theirs: grow more food, produce more oil, produce more raw materials, limit population growth, increase education, do

things and avoid unsound environmental practices, things that are essential to our survival as well as theirs. I call that investment, not aid.

Now Robert McNamara has estimated that annual investment flows in the years, in the remaining years of this decade, will have to grow from approximately 20 billion a year to about 35 billion a year from rich to poor countries, just in order to achieve a 3 percent annual per capita income growth in those countries. Where's the money coming from? One proposal which several of us made last year and which has been picked up by the World Bank, although it's still at a very low level of acceptability, the U.S. is not joining it, is to go to the OPEC countries, who as Pete Peterson told you this morning are accumulating every year huge surplus funds which they cannot spend on their own development. And take at least 5 billion per year of those surplus funds and put them to work in the developing world. Today most of that money is going to Europe and North America, and the OPEC countries are putting very little of their money into the developing world. To be specific, an article in *Foreign Affairs* which has done a thorough research, the author of which did a thorough job of research on this, shows that the OPEC countries are being just as niggardly in helping the Third World as I'm afraid the United States and the Soviet Union have been. The total amount of OPEC aid last year—I'm talking about real concessional assistance, not loans on commercial terms—was 2 billion dollars. Two-thirds of that was concentrated in the four so-called front-line countries in the world, with Israel, Syria, Jordan, and the U.A.R. Another quarter went to Islamic countries, leaving about 8 percent for everybody else. And that's just not good enough.

So what is required is a new act of statesmanship in which the OECD countries and the OPEC countries, and if possible even the communist superpower, would get together and really do something for the non-oil-producing/developing countries. And the idea which several of us have put forward comes essentially to this: to issue World Bank bonds every year in the amount of 5 billion dollars, commercial bonds bearing commercial interest rates of 8 or 9 percent to the OPEC countries, take that 5 billion and let it out on very concessional terms with 10-year grace periods, 50-year maturities, 3 to 4 percent interest, and subsidize the difference with a subsidy fund. And if you calculate it out as we have with the help of the World Bank staff, you can transmute 5 billion dollars of hard into soft money this way for about a billion and a half a year. And the dividing up of the cost of that subsidy fund would then be done between the OPEC and the OECD countries, and it comes out to a very small amount of money, relatively speaking, for each country. That's one specific idea.

A second idea which I urge, because I believe it's incumbent upon us to be concrete as we come towards the conclusion of this meeting, is to apply on a generous basis a portion of the revenues, and they will be very substantial revenues, from the exploitation of oil in the sea bed and hard minerals in the sea bed. A very large proportion of those revenues should be turned over to international financial institutions for sound lending to developing countries. I should speak carefully because I'm in the presence here of a former executive director to the Inter-American Development Bank, and I'm sure he will have very expert advice on this subject. But the idea that I have in mind, Mr. Ambassador, is if we put a relatively small royalty on the offshore oil exploitation beyond the 200-meter depth mark and a royalty also on the seabed mining, which will soon begin in the Pacific and Atlantic oceans, we could generate very substantial amounts of money for international development purposes. And it's really only equitable to do this because these areas of the world were traditionally considered beyond national jurisdiction. And if we're going to let countries operate in these areas, then the international community ought to get some fair share of the profits. A colleague at Vanderbilt University has estimated that a 10 percent royalty on revenues from sea bed oil exploration beyond 200 meters could yield as much as 3 billion dollars a year for international development, and royalties from sea bed mining something close to 1 billion dollars a year. And this would be a very practical way of providing the additional investment that the World Bank finds necessary to assure minimum rates of growth.

And then I think we could consider new ideas along the lines of an international investment trust. The new idea which was spoken of or referred to briefly by Peter Peterson this morning, which Mr. Kissinger will shortly be announcing in Nairobi, comes essentially to that. Given the problems that face private investors in

resource extraction in the developing world, the time may have come to set up a new international entity which could issue its shares to OPEC countries, to OPEC private investors, to private investors in the West, and then invest in oil exploitation or mineral exploitation in the Third World, providing security of investment which is not available to any single investor and providing a diversification which is not available to any single investor. And the International Resources Bank, which as I say Mr. Kissinger will shortly be proposing, according to the best information we have from Washington, is a step in that direction.

Now I turn to the third subject, which is international trade. I shall simply say on this subject that in the long run the developing countries can only earn the foreign exchange they need for development through trade, not aid. And this will require a new industrial geography of the world, and it will require that we practice internationally what we preach domestically, which is trade on the basis of comparative advantage. We simply cannot be in the position of saying to the developing countries of Africa, Latin America, and Asia, develop your industry and your agriculture, and then as soon as they become successful, hit them over the head with import restrictions as soon as they market to the United States. That is simply not a viable position for the United States to be in. It doesn't make sense. And therefore we have to face the implications of this new industrial geography. It's been estimated by the World Bank again that if we eliminated the obstacles we now maintain to the processing by the developing countries of their own raw materials—just the import barriers on processing of raw materials—the foreign exchange earnings of the developing countries would increase by 7 billion dollars a year by 1980. So these are things we're going to have to face. There will be adjustments within our own country, but if we embark on a long-term program perhaps over 10 to 20 years along with the Japanese and Europeans, because they should make the same kind of adjustments as we ask of ourselves, this can be done in a way that improves our welfare as well as the welfare of the developing countries.

A fourth area is the world food problem. And here we have to be very specific about what the agenda now is. There was a World Food Conference at Rome in November 1974. A commitment was made to set up an international grain reserve system, and negotiations are now lagging on the implementation of that proposal, partly because the United States is not exactly enthusiastic about it, partly because other countries are not very enthusiastic. And the worst of all, I'll be quite frank to say it, is the Soviet Union—the Soviet Union which has come into the world grain market buying up huge amounts in recent years on a very sporadic basis and being the principal source of world food instability. This year the Soviet Union will be importing 30 million tons of grain after several years in which it was importing very little. The U.S.S.R. accounts for 80 percent of the annual fluctuation in world trade in wheat, which is the principal world grain in international trade, and yet they don't want to join the international grain system and take any responsibility for holding stocks. To put it bluntly, they want the benefits of interdependence without the burdens, and for reasons that escape me we go over to Moscow and make a bilateral grain agreement which promises them a minimum of 8 million tons of grain every year and do not demand of them the minimum which is that they take part in this international grain reserve system and hold reserves like everybody else.

As an aside, I'm not afraid to use the word "detente." My quarrel with the policy is the very opposite of Ronald Reagan's. It's not that I oppose collaboration with the Russians, but I want genuine collaboration in which they do their proper share for saving the global system. But somehow they get off with a free ride every time. And they have on the food fund.

A fifth area I would mention is environment. We started again through the UN a modest international program. 1972 was the Stockholm Conference. Again the follow-through has been very weak. We need a global system to keep under review what's happening to our earth, water, and atmosphere and to evaluate through international scientific consultation the meaning of all this. We need an international environmental impact statement system in which countries would regularly report on their activities which affect other countries in the global environment and subject themselves to some kind of international review process. The Law of the Sea Treaty which is now under negotiation in New York is totally inadequate from an environmental point of view, and when it's brought to the United States Senate, I hope every environmental

organization in this country will lobby against it. And the reason is very simple because in our national delegation to the Law of the Sea Conference, the people concerned with environment are so far down on the totem pole that their concerns do not get reflected in the American position.

Sixth is the population issue which has been mentioned by many people today. We need a world population program. And General William Draper, before he died two years ago, estimated that anything less than 2 billion dollars a year devoted to fertility reduction wouldn't be enough. This is what's required as a minimum to make it possible for every woman in the child-bearing years in the developing world to limit her pregnancies. This is what it costs based on field studies per person. Two billion dollars of investment will be necessary to make unwanted pregnancy unnecessary in the world. And one figure which is rather shocking that the world, that the Population Council has developed in its field work, is that 40 percent of the children born in the developing world today are unwanted, in the sense that those pregnancies would not have occurred had access been available to modern means of information of family planning. And I say to you that a program to eliminate unwanted pregnancies would be one of the greatest liberating undertakings in the name of human rights that we could possibly imagine. But it's going to cost money because, as you all know, the major problem in fertility reduction is not getting pills or intrauterine devices out, it's education and motivation, and you need a network of health and social services to do the job. We haven't even begun to do that. In India today, with 550,000 villages, not 15 percent of the Indian women in the rural areas are protected against unwanted pregnancies. We haven't even begun.

Energy. I'll just make this remark on energy. There's so much to say. I don't believe that in the next 5 years there's going to be an agreement between the OPEC countries and the Western countries on oil prices or on the availability of supply. It might be nice. We say that's the purpose of this Paris dialogue. But it isn't going to happen. It isn't going to happen on access to supply because until the Middle East problem is solved, the Arab countries will not formally renounce the oil weapon. And secondly, we don't have enough shared uncertainty about future prices to make agreement possible. At the present time we would only accept an oil commodity agreement if the Shah and his friends accepted a big roll-back, and he won't accept a roll-back. He wants indexation, and we rightly will not grant it. So there won't be a formal agreement, but there will be other kinds of agreements. And, in the end they may be more important.

We will continue to negotiate on a friendly basis with the OPEC countries. We will make major commitments to their industrialization. We will make commitments to accept on a fair basis their investment capital. Together we will invest in new sources of energy in our area and in the Third World, and out of this will come a higher degree of interdependence and, I think, gradually a common policy. But it won't be tomorrow, and it won't be the day after tomorrow.

And I'll say one other thing on energy, if I may, and that is that it is anomalous that there is no world energy agency capable of performing the minimum international tasks that rational men would want to be performed in this area, which are global assessment of energy needs and resources, global coordination of research efforts on new sources of energy, global financing of the considerable energy resources lying in the developing world, and global assistance to developing countries in developing sound energy options. Now this is a very practical matter. Let me give you one example. Many developing countries now, lacking any sound basis for making energy policy because they don't have all the information or the trained people, are making premature commitments to the nuclear options—premature commitments that are sowing a harvest of woe for them and for us. A world energy agency, which could enable such countries to evaluate their energy options across the board and to draw more adequately on the abundant sources of fossil fuel and new technologies like bioconversion and solar power and avoid the nuclear option, would be a blessing for all of us. And with that, to avoid the Faustian bargain, as some people call it, with nuclear reprocessing plants all over the world producing plutonium which can be converted to weapons purposes. We must avoid that. Put a ban on the export of reprocessing, plutonium reprocessing facilities which are now being merchandised around the world by the Germans and French in a mad commercial race. Stop this nonsense, establish international reprocessing facilities and guarantee the availability of nuclear fuel to developing countries so

that they do not have a motivation to develop this kind of dangerous nuclear independence which will lead to weapons proliferation.

And the eighth point I wanted to mention was the restructuring of the international institutions. As Pete Peterson said so well this morning, we can't expect the OPEC countries to come into these international undertakings unless they get a fair share of the decision-making power. Let's bring them into the business. Up until last year the Arab members of OPEC had 2 percent of the votes in the World Bank, and then we hold our annual World Bank meetings on high holy days like Ramadan and wonder why they don't come. And now in our great generosity we increase their share to 5½ percent. Well, I think the time has come to think of a new international deal, in which in return for putting up the money they get a fair share in decision-making power over the use of the money. And conversely in international institutions run by a one nation, one vote system like the General Assembly, and the General Agreement on Tariffs and Trade, the system is totally absurd because you cannot have a decision-making process in which you can have a two-thirds majority composed of countries that put up 5 percent of the money and represent only 10 percent of the population of the membership. Such a process, in our Bicentennial year, will be regarded as taxation without representation, and a lot of tea is going to be thrown in the East River unless we do something about that. So just as we fix up the weighted voting in certain institutions which we control, there has to be an adjustment in other institutions operating on the one nation, one vote basis to assure that decisions are taken on a basis of consensus with the full participation of those who are asked to make contributions and implement the decisions. Well, this has been a rather long list, and I would say much more, but I would be keeping you more than I wish.

I would just close with this observation. The problems that we face in this new survival pact are not just conceptual, but political. The political systems of the world, whether democratic or totalitarian, reward leaders for maximizing present benefits for their people while passing on the costs to other countries, to future generations, and to Mother Nature. Foreigners have little leverage unless they're powerful enough to grant important benefits or inflict severe penalties. Children don't vote, and unborn children vote even less. Needless to say the earth, the atmosphere, and the oceans have no political franchise. But out descendants will curse us the way we are debasing the quality of their lives, and Mother Nature will eventually take revenge on all of us.

And therefore we need some countervailing power to the natural tendency of national political systems to produce policies for tomorrow's election, and the devil take the hindmost in the future. And that countervailing power can only be provided by two things, as far as I can see. One is international private associations to bring pressure on governments through transnational action—international conferences like this and the networks of like-minded people that they represent—and also international, intergovernmental institutions, like the World Bank, the United National system, the UN Environment Program. Only through some countervailing power against the selfish, short-sighted action of national governments can we move rapidly enough to this survival pact. We will do most of these things eventually. Of that I am convinced. But as a British critic once wrote: "The perpetual tragedy of history is that things are always being done 20 years too late." Let that not be the epitaph of our global civilization. Thank you very much.

Discussion

Question: More than a question I just would like to make a suggestion if I may. It is quite disgraceful to look at the attendance at this conference. We are having problems all over the world, and speaking from Colombia and from Latin America we see a lot of solutions that you have presented to us over here. And yet, if this had been a duplicate of the carnival in Rio the place would have been full. It is quite disgraceful speaking for my country and for my brother countries in Latin America to see the attendance up here at this excellent meeting. And I just would like to suggest, Dr. Rogers if I may, that we make use of this wonderful presentation of these gentlemen that have come up here, of the time they have invested, and that we send a copy to the Presidents of the Latin American Republics to begin with. Hopefully we can make a translation and this is what I intend to do when I go back to Colombia, make a translation in Spanish, and make it available to the ministers and to the President. When I was listening to the wonderful presentation this afternoon, I was thinking that we shouldn't limit it only to Colombia. I think that we should take advantage and present it to the other countries as well. It is a disgrace, like I say. I feel ashamed of being from Latin America and being so poorly represented. Pakistan, for instance, yesterday had a very good suggestion and they are seeing how they can attract oil companies over there. In Colombia, just a year ago I had a very bitter argument with a former Minister of Mines and Petroleum, because he could not forecast that we were going to have an energy crisis in Colombia. Today we are importing 25,000 barrels a day. And he was the Minister of Mines and Petroleum in my country. What kind of leaders do we have? Anyway, thank you.

Question: You expected me to ask you a question, didn't you? First of all, let me thank you for the speech. It was really a very very clear presentation of the facts. In fact, what we have is a clear choice between Hades and Utopia. Now perhaps the truth would be somewhere in between. What I would like to clarify is the mention you made about aid given to India. I would like to differ with you on one point—that it has not gone down the drain. The GNP of India and the industrial output has increased a tremendous amount since independence, and it has been very largely through international assistance. We have very large steel mills, we have huge power plants, we have huge water dams. It has been largely through American assistance. Russian assistance has given us very huge steel plants and a lot of countries have tried to help us. Now it has been largely due to the population rise that many of these effects have been wiped away. And I am not denying there are inequities in our system, but if you have noticed recent news we have started taking effective steps. We have introduced, I think perhaps the first time in the world, compulsory sterilization in some states for people who have had more than 3 children. And in other things also what we are trying to do is evolve our own base. I'll give you one example, because I am a businessman now, and when I went from this University of Texas I was also full of American ideas, and I wanted to do a bit of my own foreign aid. So I started a factory. I had six workers and I set up according to the American system. Instead of paying them once a month, I'd pay them once a week. And then I said that the wages that they are being paid are too low, so I doubled them. Okay, they worked, they came, I paid them double the wage on Friday; and Saturday, Sunday, Monday, and Tuesday they were gone. All six workers. They came back Thursday morning, and I found that three of them had been drunk, two of them had lost their money in gambling, and one fellow had gone and put all of his money into numbers. So, it is funny. I didn't find it very funny then; I learned one thing, and that is something that I think all of us should learn. It's that if you give money to somebody, you should know that you should also educate that person how to use it. You should not cause a cultural shock or a monetary shock like that. People have realized this now, and the aid that is coming now is much more sophisticated and therefore it is much more useful. For example, take food aid. You gave millions of tons to us in under Bill 480 and it was free. But it wasn't free because it was tied down to the fact that it had to be transported in American ships. And the shipping charges were said to have come to more or less what we would pay if we had

purchased the grain. So I do not want to go further since it's really a short meeting, but let me thank you once again. I think it was a wonderful speech.

Gardner: I deeply appreciate your remarks. Despite an impression I might have created by some critical comments, I feel a deep commitment to your country. I have had the privilege of visiting there, but I felt I had to say what many of us feel that looking back over the last 20 years we haven't seen in India the kind of improvement in the material living standards of the average man that we had hoped. As you said, rightly, there are the steel mills. There is the undoubted increase in GNP. But when you take into account the increase in population, the per capita income really hasn't changed very much, and the distribution of income within the country is something that I think is troubling. And I'm glad that we agree that those are real issues and that your government is now attacking the population problem with a degree of commitment that was not previously present.

Question: I would like to ask all of you to consider not placing the onus for population control on women. Speaking as one woman who has taken the birth control pill, I have great reservations about taking that pill for any woman and I wouldn't ask any woman to do this. I would hope, rather that we could consider vasectomies or some safer way.

Gardner: Well, our Indian friend is more of an expert on this in his own country than I am, but I believe the vasectomy is a method being very widely used in India, isn't that correct?

Question: The proposed law states that first of all they are supposed to behave in a sensible manner, and if it happens that they have more than four children and the couple is below 50 and 45 years of age, then one or the other, depending on the mutual understanding, would have to undergo sterilization.

Question: I want to thank Dr. Gardner for the first time in this conference for giving us something that is not terribly dreary, after we got through with the first part of your talk. You've given us, not a threat but a challenge, and I think this is what this is. This is the greatest time we have ever had in world history for challenges, and the young people in here should see these things as challenges not as threats. I think you would agree with that. One question. How do we get on with implementing these eight things that you said? What, practically, can we as individuals do? Do you have some suggestion there?

Gardner: I'm always terrified that someone will ask me that question, because that is the question to ask and it's the hardest question to answer. Because the only honest answer—the only thing individuals can do—is work within and through the political system of our country. To see to it that our leadership in Washington gets on with these things. And how you do that depends on your party affiliation and your approach to the next election. But whoever's elected, the message has got to be transmitted from people like ourselves that these are top priority matters. It is really shocking when you think of the level of debate about world problems in this election year. What candidate is addressing himself to these fundamental challenges, to use your word, for human survival? We have seen candidates outbidding themselves to say that under no circumstances will we ever give up American ownership of the Panama Canal which we never had ownership of to start with. That's the level of political discourse on global issues in 1976. So, I think we have to send a message to the political leadership that the time has come for a serious discussion of these matters and the kind of American leadership on these things that characterized our policy after the second world war.

Energy and Man

Dr. William S. White
Author, journalist, Pulitzer Frize recipient

The most apposite for my purposes here of the various definitions of the word "energy" is expressed in Webster's in these words—so powerful in their laconic flatness: *"An entity rated as the most fundamental of all physical concepts."*

Now, this is another way of saying that of all the myriad measurable elements of material life, this is the greatest. It stands therefore in solitary and brooding uniqueness in all the field of the palpable. It stands in the order of mankind's values and needs just short of the spiritual, the mystical and of the unknowable frontier of mankind's capacity even to ideate and to imagine.

It is this enormous, this scarcely comprehensible, truth that makes the problems before us take on so huge and in a way so menacing—the word "menacing" I shall attempt to elaborate in a moment—a set of dimensions. I say menacing not in terms of the obvious—that we must have fuel to sustain economies, armies, fleets of sea and air, nations themselves and, in the ultimate, human life itself. I say "menacing" in that here we are dealing with something so little understood in its implications in our ordinary daily lives as to be for practical purposes unknown except in the most superficial sense.

Fire—that is to say the rawest form of energy—was one of primordial man's earliest and most awesome discoveries—so awesome that he worshipped it along with other energy gods such as that of the sun. Countless millenia later the people do not of course worship energy; and the same countless millenia later the people still feel a subliminal, an atavistic, and a wholly un-

conscious dread to face the immense realities of this incredible force.

When we think or speak of "energy" we prefer to think of it in comfortably familiar terms: The gasoline station pump with its accompanying attendant; the electrician who comes to read the meter; the fuel oil truck that we see bowling about the streets.

Visitors to the Holy Land often are made deeply uneasy by the inescapable evidence all around them of an indescribable antiquity in a little dusty corner of the earth that so improbably produced three of humanity's great religions. Sometimes, they wish all of it simply to go away and so they rush to the nearest tavern and turn on the juke box. I do not speak of mere cultural barbarians visiting the Holy Land; I speak of reasonably sensitive and educated people. They are, as my friend Avram Harman, a former Israeli Ambassador to the U.S., once put it to me smilingly, "victims of cross-cultural shock."

So it is, in a sense and to a degree with the public when it is asked to stare unflinchingly at the real—as distinguished from the surface—meaning of energy and of the energy crisis.

Just as Christians with far from perfect virtue and faith prefer not to dwell overlong in the grotto of the Annunciation, so in a quite unspiritual but otherwise quite similar reaction do people recoil in discomfort and a fear having ancient roots when they must be told that it is not inconceivable that we shall run out some day of that thing that underlies all movement and growth on earth and that even makes it possible for man to eat enough, to refer to Mr. Cook's brilliant and quietly terrifying paper on food and its indispensable ingredient called energy.

When faced with imponderables about as profound as the suggestion, say, that the very seas might one day lie baked in mud, people react in perhaps three ways. They may shut their minds altogether, silently saying to themselves *take that thing away*. They may respond with the oh-yeah cynicism of the unlettered; the sophmoric skepticism of the man who has read one book and one only. They may, alternatively, compulsively reach for the devil theory for their solace: There is a conspiracy afoot; somebody is trying to frighten us in somebody's lust for power or wealth.

All three of these types of public reactions to the energy crisis may be seen by the discerning. But it is of the most capital importance neither to scorn nor to ridicule them. What *must* be recognized by those who are working, as you have been working here, to find a way out is that the energy crisis cannot be managed by impersonal scientific expertise and cool sophisticated planning alone. It must be managed by *people*; more specifically by people leading other people. And the led must be tirelessly assured and reassured of disinterested good faith of the leaders.

Upon the experts, then, lies a burden not too unlike the burden of command in military operations. The morale of the troops, of the rank and file—in this case one might say "the consumers"—must have the highest of all possible priorities. Without this, "conservation drives" will do little good, as I think Mrs. Rostow, for one example, has implied in her gentle way. Without this, fuel-saving devices may be fostered and fabricated, to be sure, but the good they will do will be marginal.

For all that I have heard and read in and from this seminar, as a writer and thus by definition a non-expert in the most quintessential sense, tells me that we have the scientific, the technical, the geological, and the management skills to bring us safely through— so long as we have the wit always to see that the heart of the matter here lies not in procedures, however sound, but rather in people, however illogical at times.

I believe, that is to say, that the recovery of additional energy and the finding of additional sources for it defines the first problem, but that the final and crucial and overmastering problem is political. I mean political, of course, in its larger senses.

This is to say two things: That the politician must in the end occupy the top command post and that he must have not simply the tolerance but the active support of a powerful majority of the total American constituency. In that sense, the experts must all give way to him in the end, not because he is better or smarter than they are, but because it is his skills and his form of power that are conclusively vital to the enterprise.

Once, during the war, I sat in the gallery in the House of Commons in London when much was being made of a victory that Marshal Montgomery had won down in Africa. Prime Minister Churchill, a Cavalier type who loathed the austere and Cromwellian Montgomery, with all his vegetarianism and teetotalism, snorted in displeasure and announced to the

House: "Ah, but Montgomery is only the hammer in the hands of Alexander." (Lord Alexander was Montgomery's superior officer. But more important he was Churchill's friend.) That the judgment was fair I do not contend. That the anecdote is pertinent and relevant here I *do* contend. For all the experts must in the end be the hammers in the hands of the elected political leadership of the United States—first, the President, whoever he may be, and then the Congress, whatever partisan complexion it may have.

After all, a totality of national effort is clearly required here, and for this a powerful—and reasonable—national leadership is manifestly indispensable.

In order to attain the high goal of national sufficiency in energy, the most tremendous of obstacles, foreign and domestic, must first be overcome.

Few would disagree, on the basis of all we have heard here, for a single illustration, that unless and until our country can live comfortably entirely on its own energy resources, some tolerable *modus vivendi* must be stuck up with foreign producers and notably, of course, with OPEC. Given this fact of life, the government of the United States must be powerful enough—and unified enough—to deal in enlightened tough-mindedness with foreign governments which have, in whole or in part, covertly or openly, put themselves in charge of the oil business of their countries.

For this mission our government, as has been pointed out again and again here, needs in turn the active cooperation of other oil-deficit nations not all of which are going to share our concepts of truly free capitalism, however valid these concepts are to you—and to me. As we all know, Napoleon once asked for nothing better than to meet an enemy who had allies. While the notion is unduly cynical to apply to our own situation, there *is* a chemical trace of truth in it.

Again, there is the matter of the basic needs of the under-developed nations and our own obligations toward them. It is hardly necessary to point out that here, too, the problem ultimately is one of politics of the international variety. For such nations must be persuaded in their own interest to avoid pulling the American Eagle's tail feathers on pain of arousing the anger of the American people to such a level as to make it difficult to deal rationally with this aspect of the problem.

In a word, in a dilemma of international scope no one and no power save that of government can deal finally with it, either legally or effectively. Never before has American diplomacy had so peculiarly demanding a task.

As to matters here at home, it would be foolish not to realize that two great dangers to a responsible solution are all too visible—and all too plainly require political solution in a court of last resort. The first of these is a wide suspicion that "the big oil companies" have somehow manufactured a shortage in order to gouge the common man. The second is a sometimes frenetic insistence by some environmentalists and conservationists not upon a sane and wholly justified protection for the ecology but rather for an impossible return, late in the Twentieth Century, to the forest primeval of our distant ancestors.

Again, it will do no good to wave away these two dangers as mere left-wing irruptions or crackpot communes.

For while the devil theory of the evil oil company is almost demonstrably held in complete cynicism by demagogues, many honest people, however deluded, believe it, too, and will not wisely be dismissed. My long experience as a journalistic observer in Washington tells me that a certain gathering of circumstances could put the Nation in a far worse shape as to energy than it is already.

The final catastrophe from the point of view of national interest and commonsense would be a successful drive to nationalize oil in spite of the amply established reality that nationalization is the beginning of economic madness, as some of our friends abroad have so sadly learned.

Scarcely less disastrous would be a punitive fragmentation of the oil companies which as Mr. Ikard has declared are prepared to invest 955 billions of dollars in the next ten years—a most critical period. A fragmented industry could not hope to raise that much capital—if only because so much of its time and effort would have to be spent in structural rearrangement of the most enormous complexity and of unreadable consequences to industrial efficiency.

Still the fact that a given course of action makes no sense can give no sort of guarantee that it may not all the same be undertaken if responsible and sensible national leadership should find itself utterly over-

whelmed by a semi-hysterical public opinion.

It is therefore in the highest interest of all who seek to work out our difficulties sanely to preempt any possibility, however remote, of such an eventuality. Specifically, the oil industry—and indeed the energy industry collectively—must omit no step that could serve to help prevent the government from becoming naked under any possible storm of public emotionalism. (I am of course speaking here in very long terms; nothing on the horizon suggests that such a storm is at hand or inevitable. I am speaking, really, in terms of an ounce of prevention.)

The industry, in short, must work both with and visibly *under* the government, much as it has in times of war.

It would be tempting for oil company spokesmen simply to tell the more extreme of their accusatory critics to go to hell; but while this might be emotionally satisfying it would be the greatest of mistakes. Such an attitude would play into the hands of the extremists—the genuine collectivists as distinguished from those ordinary people who are simply frustrated and confused and so humanly looking for some kind of scapegoat.

Nor are conventional "public relations" going to be adequate in these extraordinary times. All who produce and market energy, bedeviled as I know they are, must nevertheless take up a posture of what Mayor LaGuardia of New York once called "patience and fortitude."

When the First Division was preparing to attack Aachen during the war, a couple of experts from the OSS turned up on a hill overlooking that city with hog-callers to announce to the Germans that they had best surrender post-haste.

As one who had seen the reality of Nazi resistance from D-Day forward and thus claimed a certain expertise of my own, I advised these officers to get off that hill without delay and to take their hog-callers with them. "Why?" they demanded. "We are here to make propaganda to ease the burden of the troops."

"In some circumstances, such as these," I replied with what I must admit was perhaps a certain imperiousness, "my experience in this damn war has convinced me that the best propaganda of all sometimes is to take an enemy position and forget about leaflets and all that." The OSS officers nevertheless remained on that hill—but not me. The Germans, homing in on the sound track of the hog-callers, sent in two rounds of mortar fire. No more hog-callers and, unhappily, no more OSS officers.

I do not claim that this anecdote makes any kind of perfect analogy; but perhaps it will roughly serve to illustrate my point. My point is that the *deeds* of the American energy producers and sellers can make them far more friends than can conventional advertising so long as those deeds are directed toward a scrupulous fairness to Joe Consumer—so long that is that he thinks the big fellows are doing the best they can in trying times.

Similarly as to the ecologists, the sensible ones must be divided from the nature freaks—who if left isolated will soon be shouting down a rain barrel—by the most active concern for ecological purity up to the point where such concern does not present a clear and present danger to indispensable energy production. For an illustration, there is the matter of strip mining.

This is an extremely sensitive point—but already we have seen some energy producers who have handled it brilliantly. And again they have done so by deeds and not words, specifically by restoring mined areas to even better condition than they had been beforehand.

Enlightened self-interest, to paraphrase Woodrow Wilson, is the golden key here both domestically and in the unavoidable negotiations that lie ahead with foreign using and foreign producing oil nations. At home the folly of get-*poor*-quick solutions, such as nationalization or quasi-nationalization of energy, or "breaking up the big companies," must be fought by quietly and persistently pointing out that throwing the baby (the people's interests) out with the bath water would hurt the baby far more than the tub—that is, the producers.

Abroad, the American negotiating power—the Presidency and to a lesser extent the political establishment in general—must operate with the unqualified backing of the domestic producing nexus, no matter who may be President next year. (No matter who he may be, by the way, I believe that in a crisis of this magnitude he will be forced by the facts of life to resist such foolish over-simplifications as trying to find enough energy through giving control to the Federal bureaucracy. Equally I believe that whoever he may be he will find a bearable accommodation with foreign interests, OPEC

and all the rest, always provided that he operates on the stout floor of a national consensus of support.)

I have been given the impression here that what we need most is time; that given the dream of national self-sufficiency in energy—from the sun, from coal, and so on—is not a wholly unrealizable one.

If that is true, then for the immediate future we ought to be on something of the footing of a war situation, accentuating all that can bring us together, accepting some self-sacrifice all around, and giving the benefit of the doubt to everything and everybody on the assumption that you *can* trust people and public and private institutions.

Too many these days are saying that trust is obsolete. A crisis in energy is no reason for a crisis of confidence.

Discussion

Question: A question for Mr. White or Mr. Gardner, or maybe both. What sources of leadership do you see in this country and elsewhere in the world today that can help lead some of these efforts? I might say that I sympathize very much with our friend from Colombia back here who protests about the very small attendance that we have here today. You'd think from a great university of 40,000 students and a 2,000 faculty that we would have more people who would be interested in being present at this great occasion. I'd be interested in where you see the leadership emerging to cope with some of these problems that we have been discussing?

White: I've got some sort of feedback or sort of an echo chamber effect on a part of that, but I think I understood the substance of the question. Well, I have no better answer than what I've said here, that we are in a situation where by definition, as I said earlier, the matter lies ultimately in negotiation, and there is nobody qualified or able to negotiate except the government, which means the President. I therefore expect the leadership to come from the President. The only qualification I make of that is what I attempted to say here that a President, I don't care who he is for this purpose, in this matter has got to be given a very, very large measure of public support, almost as if we were at war. That was the point I tried to make.

Question: I would like to emphasize the fact that in addition to the political options which Dr. Gardner very properly emphasized, we also have options as consumers —options which we can emphasize every day of our lives, in the way we make our choices which reflect on energy. Thank you.

Closing Remarks

The Honorable Edward A. Clark
Dr. Lorene Rogers

Clark:
Ladies and Gentlemen, I simply would like to say that I am deeply grateful to the many people who have given help and cooperation in making this second International Ex-Students' Conference possible. Some two years ago I asked the Board of Regents to give their approval to another conference being held. I was associated actively with the first international conference some five years ago. And I would like to say now that if I keep my health and outlive all of the people that I intend to outlive, that I can't do too much about except maybe outlive em, I hope that within the next two years we will start working on another international ex-students' conference, and from what I am convinced of, from what I have heard here, I have no doubt about the topic. The subject will be energy, and of course it will include the quality of life; it will include environmental problems and all the other problems that seem to be covered or touched by energy. I would particularly like to thank the regents for their cooperation. I would like to thank Dr. Spurr who first took over the job of being host of this conference and having final decision making over what was recommended by the Steering Committee and also by the Planning Committee of which my friend Dr. Woodson was Chairman. But the action began when the red-headed boss lady became President of The University of Texas, the first woman to be president of a major

university in the entire United States. She turned the juice on, so to speak, and it became evident that she would cooperate fully and that the conference would come off; and she gave us one of her vice-presidents to actively participate with us, Dr. Floyd Brandt, and I express deep appreciation for his fine work. Everyone has been magnificent. Our speakers have been both cooperative and have been, I think, wonderful in their presentations. I think the conference has been well worthwhile. I just wish more people concerned with the problem were here. My friend Jim Keene has asked what could be done. At the risk of oversimplification I will tell Jim that he knows Washington well. He's been there many times, and this job cannot and never will be done—though we devoutly desire the solution of the problem—it can never be done until the Congress under the leadership of the President has passed a satisfactory energy policy for the United States. We do not now have such a policy. They have taken a few whacks at it, some licks and a promise and temporary measures, but we do not have the kind of a sound, workable, practical, fair, decent energy policy that this country and its people are entitled to have. And one thing that you can do is to contact every member of Congress that you know and among other things when it is available to you, you can ask them to please read the recorded *Proceedings* of this conference. They will soon be out, and like the conference, they will be a fair and honest report. I believe that all of the people at this conference have recognized this to be an open, fair, and honest conference. There have been no stooges; there has been no one that has been brought here to express something that somebody else desired to be put forward. But we have tried first to get some of our most distinguished professors, and that was my desire as Chairman of the Steering Committee to use as many of our own faculty as we were able to produce. And certainly I was pleased by Dr. Woodson and Dean McKetta, Dr. McKie, Professor Bill White, that you have heard and other members of the faculty. I must say that my friend, Dr. Gardner, has interesting dreams. I'd like to trade some of my nightmares for that very, very interesting dream that he had last night. I think that it is priceless. You can get some good ideas with dreams like that. But suffice it to say that I have a heart full of gratitude, and I want to echo what Dr. Woodson said about thanking Clif Drummond, who has been working with the Energy Center on this affair, and has done a great job. Everyone has been wonderful. No one has been more wonderful, more cooperative, more determined to have a successful conference than the boss lady that I referred to. She's the official host of this affair, and I now call to the microphone Dr. Lorene Rogers, distinguished President of The University of Texas, who will bid you greeting and a fond farewell . . .

Rogers:

From what I have heard from those of you who have attended, this has been an entirely successful conference. And from my standpoint, it certainly has been. I only regret that my faculty wouldn't let me shut down the university for three days so that I could have heard all the papers. I did hear you, Dr. Gardner, from the closed-circuit television in the other room and it was an excellent talk. We have had some frank and hard-hitting papers given here, and this is what we wanted. We have had good interaction from the conference, and this is what we wanted. I told you on the first day that we hoped to accomplish several things. We wanted to get your ideas. Those foreign students of ours who have been away from the campus have learned a great deal since they left us as well as having learned a great deal while they were here. We feel that we have gotten your viewpoints on the problems we've been discussing here. We also had in mind showing off what we're doing here, and we hope that you have gained from learning about the activities that are going on, the kinds of faculty members we have now, the energy-related research and teaching and public service that they are now involved in. I also said that there was a less serious reason for calling you back and that was for you to enjoy yourselves in an ex-students' reunion. From what I've seen at the parties in the evening, I think you've been doing that also. You now have one more day that is just for you to do what you would like to do on the campus and visit with the people that you haven't had a chance to visit with until this time. Before I close this conference I would like to say again—I said this the first day but I would like to say again—how much I appreciate all of the effort that has gone into this conference from many, many people on this campus and off this campus. We have had support and time, interest, energy, and money that has made this conference possible, and we truly are appreciative for that. We appreciate the time that the speakers have put into this, and I agree with the gentleman from Colombia who has suggested that these papers be put into a permanent form and circulated to people over the world who should know what was said here. I will do everything that I can to see that that is carried out. And now, again, with our appreciation for your attendance and your interest, I declare this conference closed. Thank you.

Conference Speakers

The Honorable Gerald L. Parsky, Assistant U.S. Secretary of the Treasury for International Affairs. In 1971 Assistant Secretary Parsky came to the Department of the Treasury from a New York law firm where he practiced corporate and securities law. Since 1974 he has been in charge of the Treasury's policy in the trade, energy, commodities, and financial resources areas, as well as U.S. economic and financial relations with the Middle East. Assistant Secretary Parsky currently serves as Executive Secretary of the East-West Foreign Trade Board and the Joint U.S.-Saudi Arabian Commission for Economic Cooperation. He also represents the United States in the International Energy Agency and the Conference on International Economic Cooperation.

Dr. John J. McKetta, former Dean of the College of Engineering, former Executive Vice-Chancellor of the UT System, and present E.P. Schoch Professor of Chemical Engineering at The University of Texas at Austin. Dr. McKetta is a member of the National Academy of Engineering, a charter member and member of the Board of Directors of the National Council for Environmental Balance, and former Chairman of the Committee on National Air Quality Management for the National Academy of Science and Engineering. He has published over 255 technical articles and authored or coauthored numerous internationally known books and reference works in chemical engineering. In 1970 the President of the United States appointed him Chairman of the National Energy Policy Committee, and in 1975 Dr. McKetta won the coveted National Service to Society Award for his efforts in informing the public on the topics of energy and environmental balance.

Dr. William L. Fisher, Assistant Secretary of the U.S. Department of the Interior for Energy and Minerals and Director of the Bureau of Economic Geology of The University of Texas at Austin (on leave). Since 1964 Dr. Fisher has been Professor of Geological Sciences at UT Austin, specializing in the geologic aspects of energy and mineral exploration. From 1970 to 1975 he also served as a consultant to Petrobras, Brazil, in offshore gas and oil exploration and development. Dr. Fisher joined the Department of the Interior as Deputy Assistant Secretary for Energy and Minerals in 1975. President Ford appointed him Assistant Secretary earlier this year.

Dr. Herbert H. Woodson, Chairman of the Department of Electrical Engineering and Director of the Center for Energy Studies of The University of Texas at Austin. Dr. Woodson came to UT Austin after 15 years on the faculty of the Massachusetts Institute of Technology. He is Associate Director of the Fusion Research Center, a Fellow of the Institute of Electrical and Electronic Engineers, and a member of the American Society for Engineering Education. Dr. Woodson is also a consultant to the Office of Technology Assessment, the research arm of the U.S. Congress. In 1972 he participated in the meeting of the Energy Working Group of the U.S.– U.S.S.R. Joint Commission on Scientific and Technological Cooperation held in the Soviet Union.

The Honorable Frank N. Ikard, President and Chief Executive Officer of the American Petroleum Institute. A Texas member of the United States House of Representatives from 1951 until his resignation in 1961, Mr. Ikard served on the Ways and Means Committee. He has also been a member and Vice-Chairman of the UT System Board of Regents. Mr. Ikard is a member of the National Petroleum Council and a U.S. Committee Member for the World Petroleum Congresses. He also attended the U.N. Conference on the Human Environment in Stockholm as a member of the U.S. delegation.

Dr. George Kozmetsky, Dean of the Graduate School of Business and the College of Business Administration of The University of Texas at Austin. Dr. Kozmetsky is a co-founder of Teledyne, Inc., a major company in the electronics industry. A former consultant to the National Aeronautics and Space Administration management advisory panel, and the U.S. Air Force scientific advisory board, Dr. Kozmetsky serves the UT System as executive associate for economic affairs. He is a former president of the Institute of Management Sciences, a member of the World Future Society and a Fellow of the British Interplanetary Society. In addition to acting as a consultant to the Institute for the Future, Dr. Kozmetsky is on the boards of directors of a number of banking, business, and energy enterprises.

Sheikh Abdullah Tariki, former Minister of Petroleum of Saudi Arabia and co-founder of the Organization of Petroleum Exporting Countries (OPEC). A geology graduate of The University of Texas at Austin, Sheikh Tariki was integrally involved in the development of his country's oil resources and the establishment of an independent Arab petroleum policy. He was the first Arab to reach the upper echelons of the American-owned Arabian American Oil Company (ARAMCO), serving as director from 1959 to 1962. In 1959 and 1960, Sheikh Tariki led the Saudi Arabian delegation at the Arab Oil Congress, where he was a key figure in the founding of OPEC.

Mr. Masami Ishida, President of the Petroleum Association of Japan. Shortly after graduating from law school, Masami Ishida joined Idemitsu Kosan Company, Ltd., in 1938 and rose through the ranks to the position of president, which he has held since

1969. In 1972, Mr. Ishida was appointed Chairman of Idemitsu Petrochemical Company, Ltd. Since 1975 he has also served as President of the Petroleum Association of Japan and Standing Director of the Japanese Federation of Economic Organizations.

The Honorable Ronald Wm. Brown, Labour Member of Parliament, United Kingdom. After some years as a senior lecturer in electrical engineering at London's Industrial Training School, Ronald Brown was elected to Parliament in 1964. He has retained a seat ever since, serving as a member of the House of Commons Select Committee on Science and Technology and the Energy Resources, Space, and Computer Subcommittees. Since 1972 Mr. Brown has also been a member of the Council of Europe Assembly and the Western European Union, positions which he held previously from 1965 to 1968.

Mr. Abdul Majid Mufti, Economic Minister, Embassy of Pakistan, Washington, D.C. After having taken his Master's Degree in Political Science and Law from University of the Punjab, Pakistan, in 1946–47, Mr. Mufti joined the Civil Service of Pakistan in 1948. He served as District and Divisional Officer in the initial period between 1950 and 1958.

From 1958 onwards, he held senior appointments in the Government of Pakistan as Joint Secretary in the Ministries of Industries, Commerce, Economic Affairs, Water & Power Development and Works before his appointment to the present post in 1972.

Mr. Mufti represented the Government of Pakistan at the United Nations Conference on Trade and Development (UNCTAD) at Santiago, Chile, in 1972. He also attended Textile Trade Negotiations under the auspices of GATT at Geneva in 1973 and the ECAFE Conference at Seattle in 1974. In 1975, he attended the United Nations General Assembly Special Session (Sixth) at New York and the Annual Meetings of the World Bank at Washington as Advisor to Pakistan delegations.

Dr. George W. Hoffman, Professor of Geography at The University of Texas at Austin. Dr. Hoffman specializes in economic geography of the socialist countries and comparative regional development in both Western and Eastern Europe. He has been visiting professor and lecturer at numerous European universities and is the author and/or co-author of numerous books: *A Geography of Europe* (4th edition under preparation), *Regional Development Strategy in Southeast Europe* (1972), *Balkans in Transition* (1963), *The Common Market* (with J. W. Nystrom, 1976), *Yugoslavia and the New Communism* (co-author, 1962), *Eastern Europe: Essays in Geographical Problems* (editor and contributor, 1971). He is the author of numerous scholarly articles. He is Chairman of the Committee of Research and Development of the American Association for the Advancement of Slavic Studies and of the Committee on Eastern Europe of the Association of American Geographers and a member of the Academic Advisory Board of the Kennan Institute for Advanced Russian Studies, Woodrow Wilson International Center for Scholars. Dr. Hoffman was born in Vienna, Austria, received his education in Austria, did graduate work in the United States, and received his Ph.D. from the University of Michigan. He has been on the faculty of The University of Texas since 1949.

Professor Elspeth Rostow, Dean of the Division of General and Comparative Studies at The University of Texas at Austin. With a broad background in the social sciences, Professor Rostow has taught in a number of colleges and universities in the United States, Austria, Switzerland, and England. Joining the UT Austin faculty as an associate professor of government in 1969, she was named Dean of General and Comparative Studies in 1975. Her publications include books and articles on international economics and political issues.

C. W. (Tex) Cook, former Chairman of the Board of General Foods Corporation. Serving as General Foods' chairman from 1966 until 1974 and the company's president from 1962 to 1972, Mr. Cook continues as a director of that corporation and several others. He is former director of Chase Manhattan Bank. For more than ten years, he has also counseled government on issues related to food and the economy. He was Chairman of the Food Sub-Council of the National Industrial Pollution Control Council and a trustee of the Committee for Economic Development and the Council of the Americas. In 1969 the President of the United States named Mr. Cook chairman of the panel on food processing and manufacturing for the White House Conference on Food, Nutrition, and Health. He was also part of the National Advisory Commission on Food and Fiber appointed by President Johnson to make long-range appraisals of U.S. agriculture and related foreign trade policies. Mr. Cook is an engineering graduate of The University of Texas at Austin.

The Honorable Peter G. Peterson, former Secretary of Commerce of the United States. After an early and brilliant career in marketing and industry, which included his election as President of Bell & Howell at the age of 34, Mr. Peterson joined the White House staff in 1971 as Assistant to the President for Economic Affairs, in which capacity he had a great influence in the establishment of U.S. international economic policies. In 1972 the President named Mr. Peterson Secretary of

Commerce and Chairman of the National Commission on Productivity. During that same year he was also U.S. Chairman of the U.S.-Soviet Commercial Commission that negotiated comprehensive commercial and lend-lease agreements. He played a similar role in that year's U.S.-Poland trade agreement. Since 1973 Mr. Peterson has served as Chairman of the Board of the international investment banking firm of Lehman Brothers Incorporated. He is also a member of the boards of directors of several large corporations.

Dr. James W. McKie, Dean of the College of Social and Behavioral Sciences and Professor of Economics at The University of Texas at Austin. Dr. McKie is a specialist in industrial economics, the regulation of industry, and the economics of energy and natural resources. Having taught at several of the country's leading colleges and universities, he has recently published books and monographs dealing with energy and social responsibility. Dr. McKie was a member of President Johnson's Task Force on Antitrust Policy. In 1969–70 he was chief economist for a Presidential Cabinet Task Force on Oil Imports Control and co-authored the report of the task force on the relationship of oil imports to the national security. He has also been a consultant to the President's Council of Economic Advisors, a member of the National Science Foundation Advisory Committee for Environmental Sciences, and a member of the National Academy of Sciences/National Research Council Subcommittee on Emergency Energy Capacity. Dr. McKie is a Phi Beta Kappa graduate of The University of Texas at Austin.

Dr. Richard N. Gardner, Professor of Law and International Organization at Columbia University, New York City. An expert on the interrelationships among food, population, economic growth, and resources, Dr. Gardner holds the Henry L. Moses Chair of International Law and Organization at Columbia University and also acts as Special Counsel to the New York Law firm of Coudert Brothers. He has served as a member of the President's Commission on International Trade and Investment Policy and as a legal advisor to the United Nations Secretariat at the Stockholm Conference on the Human Environment, where he helped design the new U.N. machinery for environmental cooperation. From 1961 until 1965 Dr. Gardner was Deputy Assistant Secretary of State for International Organization Affairs. He has written and worked on a wide variety of foreign policy problems, with particular emphasis on international economic policy, international law, and the United Nations. Dr. Gardner is a Fellow of the American Academy of Arts and Sciences.

Mr. William S. White, author, journalist, and recipient of the Pulitzer Prize in Letters. An alumnus of The University of Texas at Austin, Mr. White has held numerous positions in the national journalistic scene. He was a war editor and war correspondent for the Associated Press during World War II, a member of the *New York Times* Washington Bureau, a Congressional correspondent, a political columnist, and a contributing editor for *Harper's* magazine. He has also taught journalism at the University of California at Berkeley. Mr. White has written five books, two of which have been best sellers. One of them, *The Taft Story*, won him the Pulitzer Prize for Biography in 1955. Mr. White is currently adjunct professor of journalism at The University of Texas at Austin.

Conference Leadership

Dr. Lorene L. Rogers, President of The University of Texas at Austin. A biochemist, Dr. Rogers received her M.S. and Ph.D. from UT Austin. In 1949 she joined the University faculty, where she has taught both chemistry and nutrition. She has served as Assistant Director of the Clayton Foundation Biochemical Institute, Associate Dean of the Graduate School, and Vice President of the University. Dr. Rogers has been a member of a number of national committees on advanced education and is also a Fellow of the American Institute of Chemists.

The Honorable Edward A. Clark, former United States Ambassador to Australia, Regent of the University of Texas System, and Chairman of the Steering Committee for the International Ex-Students' Conference on Energy. A law graduate of The University of Texas at Austin, Ambassador Clark is a senior partner in the Austin law firm of Clark, Thomas, Denius, Winters, and Shapiro and a Fellow of the American Bar Association. He served as Texas Secretary of State, as assistant to former Governor James V. Allred, and as Assistant Attorney General of Texas. Mr. Clark is currently on the boards of directors of several banks and corporations. He is also the former American Executive Director of the Inter-American Development Bank in Washington, D.C.

Dr. Herbert H. Woodson, Chairman of the Planning Committee for the International Ex-Students' Conference on Energy. (See Conference Speakers section for further biographical information.)

Roy A. Vaughan, Executive Director of the Ex-Students' Association of The University of Texas at Austin. A graduate of UT Austin, Mr. Vaughan has been on the staff of the Ex-Students' Association since 1963, as a field representative from 1963 to 1968, as Associate Executive Director from 1968 through the end of 1975, and as Executive Director since January of this year. Mr. Vaughan is a member of the Council for the Advancement and Support of Education and the American Alumni Council.

Jack Maguire, former Executive Director of the Ex-Students' Association of The University of Texas at Austin. An author and columnist specializing in the more colorful aspects of Texas history, Jack Maguire is a journalism graduate of The University of Texas at Austin. For 20 years he served as Executive Director of the Ex-Students' Association, establishing such programs as the Distinguished Alumnus Awards. A member of the International Ex-Students' Conference on Energy Planning Committee until he left the Ex-Students' Association in January, Mr. Maguire is currently Director of the Institute of Texan Cultures at UT San Antonio.

Dr. Joe W. Neal, Director of the International Office and Professor of Speech Communication at The University of Texas at Austin. Originally trained in Latin American studies, Dr. Neal has received three degrees from UT Austin and began his teaching career as a member of the Department of Speech in 1938. In 1941 he was named Foreign Student Advisor. Since that time, his responsibilities have grown to the point where he now advises the University's 2000 foreign national students, assists 150 visiting scholars from abroad, coordinates special overseas programs in 12 foreign countries, and maintains contact with former students and faculty around the world. A frequent world traveler, Dr. Neal has served as a consultant to the U.S. State Department, the U.S. Office of Education, the Institute of International Education, and the Ford Foundation. He is a former President of the National Association for Foreign Student Affairs and is currently one of five national senior consultants on international program organization at the university level.

Dr. Floyd S. Brandt, Professor of Management and Industrial Relations and Director of the Office of Analysis and Planning. A former member of the faculties of several of the country's most respected business schools, Dr. Brandt served as Chairman of the Department of Management at UT Austin from 1968 until 1972 and assumed the duties of Assistant to the President in 1974. He also served as a U.S. Delegate to the OECD 20-nation Conference on Management in Paris and delivered a series of lectures on strategic planning at INSEAD in the same city. Several of Dr. Brandt's numerous publications deal with management in the petroleum industry.

Clif W. Drummond, Director of Liaison of the Center for Energy Studies of The University of Texas at Austin and Director of the International Ex-Students' Conference on Energy. An alumnus of UT Austin, Mr. Drummond served as the University's Student Body President for 1966–67. He also led negotiations of the first direct agreement between the student body of a major U.S. university and its international counterpart participating in the Texas-Chile Student Leader Exchange Program. Before joining the Center for Energy Studies in 1974, he was District Administrator and Administrative Assistant for U.S. Representative J. J. (Jake) Pickle for six years. As Liaison Director of the UT Center for Energy Studies, Mr. Drummond monitors energy policy decisions and legislative actions at all levels and analyzes their potential effects on energy research and development programs.

Conference Steering Committee

Composed of leaders from education, business, and industry active in the energy area, the Conference Steering Committee was responsible for the overall coordination and guidance of the conference. The University of Texas at Austin wishes to thank each of the committee members for this invaluable contribution.

The Honorable Edward Clark
Chairman
Regent, University of Texas System

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Rex G. Baker, Jr.

J. S. Blanton

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William S. White

Dan C. Williams

Walter F. Woodul

Warren G. Woodward

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Conference Planning Committee

Composed of University of Texas faculty and professionals active in the energy area, the Conference Planning Committee was responsible for the development of plans and the administration of the conference. The University of Texas at Austin wishes to thank each of the committee members.

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Director, Center for Energy Studies

Floyd S. Brandt
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Joe Culver
Director, Development Board

Clif W. Drummond
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Joe W. Neal
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John Vanston
Deputy Director, Center for Energy Studies

Roy A. Vaughan
Executive Director, Ex-Students' Association

The University of Texas at Austin also wishes to thank the staffs of the Thompson Conference Center, the Lyndon B. Johnson Presidential Library, the Michener Galleries, the Lyndon Baines Johnson School of Public Affairs, as well as the members of Alpha Phi Omega, Gamma Delta Epsilon, Women in Communications, and the Longhorn Band for their invaluable assistance with the conference.

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